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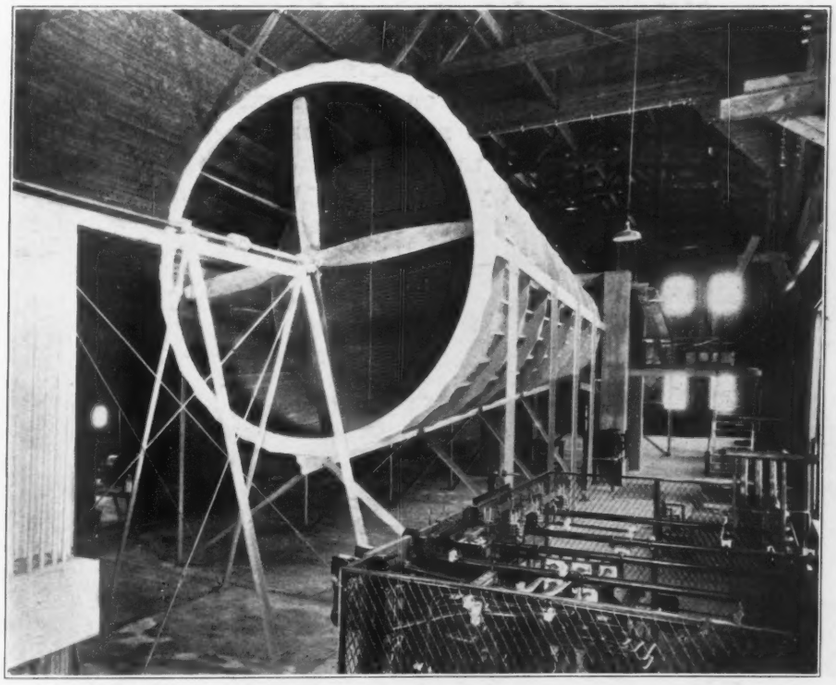

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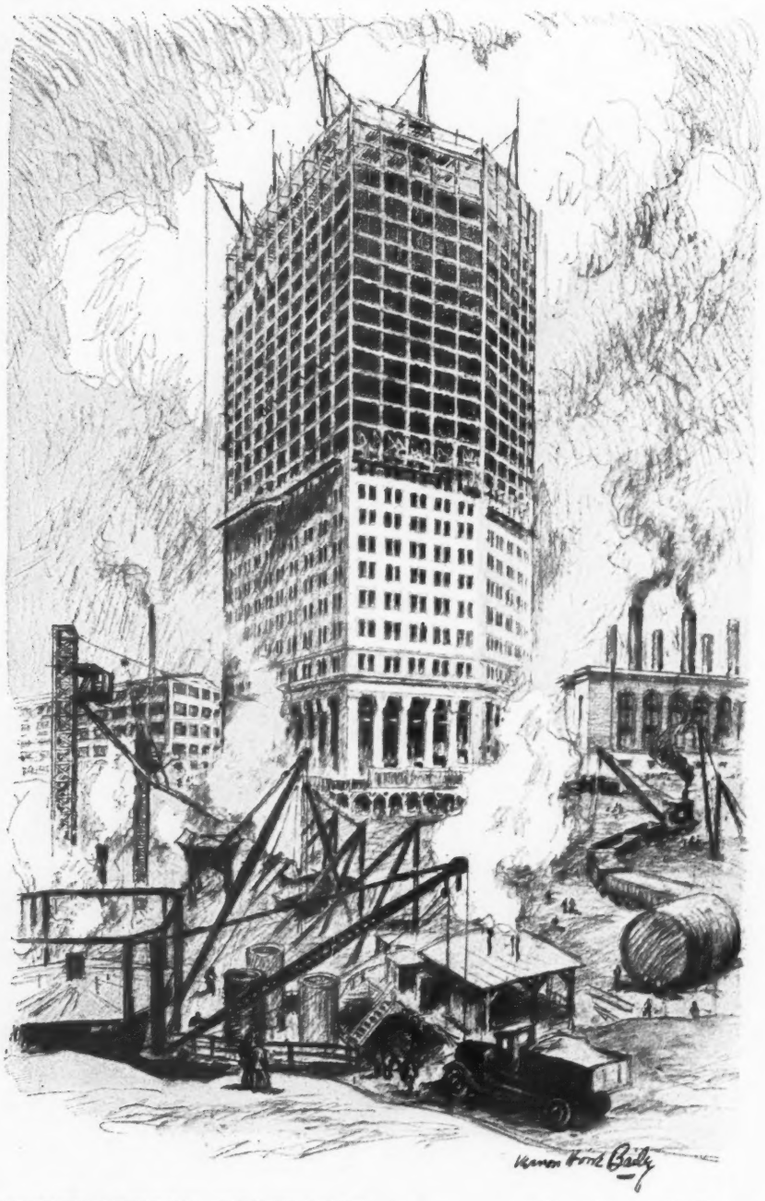

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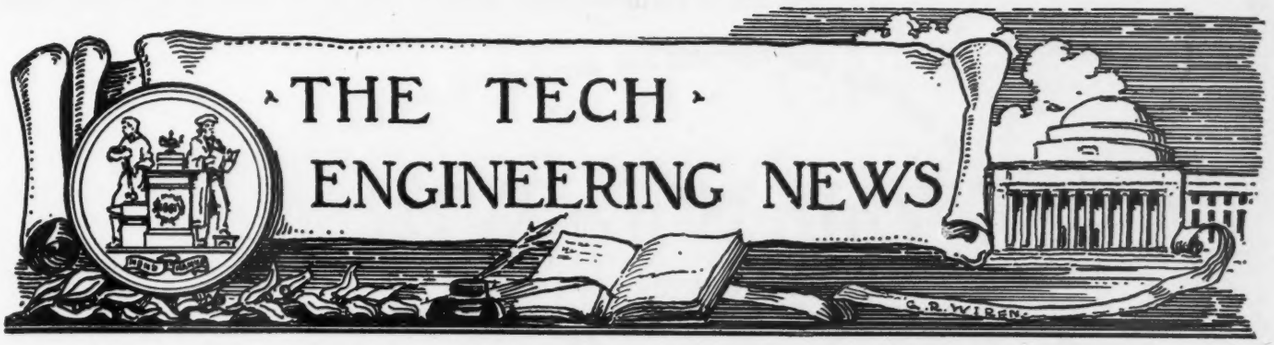

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TABLE OF CONTENTS

Page

ENGINEERING EDUCATION IN FRANCE. By Harold W. Bibber, '20 45
RESEARCH AT THE INSTITUTE. By Prof. H. M. Goodwin 46
WILLIAM I. WYMAN. By Hon. Karl Fenning 48
THE DESIGN AND MANUFACTURE OF INSULATORS. By K. A. Hawley . . . 49
MEASUREMENT OF STRUCTURAL STRESSES. By Major F. Johnstone-Taylor . . 50
FLYWHEEL EXPLOSIONS AND THEIR PREVENTION. By F. B. Tolsted . . . 51
DUST COLLECTING AND PNEUMATIC CONVEYING By F. L. Jorgensen . . . 52
WIND TUNNEL AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY. By J. R. Markham 53

To You Who Will Be Factory Engineers—

On the shoulders of you who plan to be factory engineers—production engineers, industrial engineers, efficiency engineers—rests the responsibility of answering the constant cry, "Increase production; reduce overhead; cut down costs—speed up the plant".

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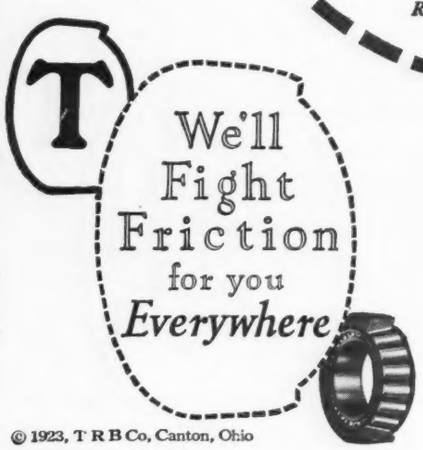

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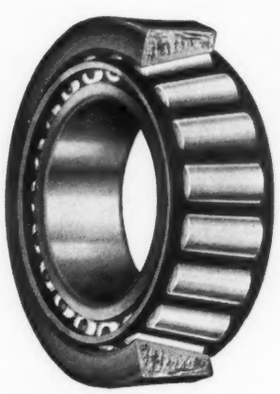

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THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE ALUMNI AND UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME IV MAY, 1923 NUMBER 2

ENGINEERING EDUCATION IN FRANCE

By HAROLD W. BIBBER, '20

Instructor, Electrical Engineering, Massachusetts Institute of Technology

In 1919 shortly after the armistice was signed, when French and American officers of the Engineering Corps were coöperating in many ways, Prof. D. C. Jackson then Lieutenant Colonel of Engineers became acquainted with certain officials of the Ecole Centrale des Arts et Manufactures of Paris, and an arrangement was made whereby an exchange of instructors in engineering should be effected between it and the Massachusetts Institute of Technology. An exchange of this sort had never before been attempted and the author was the first to be sent in this capacity by the Institute.

The author's knowledge of spoken French was no greater than that of most Americans who have studied modern languages in our schools. His first intimate contact with the educational system of France came, therefore, soon after his arrival, when he went to the summer school of the University of Besancon to study conversational French. There he became acquainted with the students, the professors for whom he came to have unbounded admiration and also with the methods they employ in higher education.

The French university may have faculties of letters, science, law and medicine. Some universities have not the full quota of four, but all have the first two. The university matriculation fees are nominal so that all classes of students may attend. Usually three years is required to obtain a degree such as "License ès Science" corresponding nearly to our M.S., the student previously having obtained the "baccalauréat" or its equivalent. This latter is similar to our high school diploma though the subjects covered include many taken in the first and second years of our college courses.

France has two systems of elementary education, one gratuitous which provides the essentials needed for useful citizenship, the other, requiring the payment of tuition, teaching cultural as well as utilitarian subjects.

The candidates for the "baccalauréat" come principally from those having passed through the schools requiring tuition. This diploma is awarded when a series of written and oral examinations in all subjects covered by the pupil have been passed before a board of university professors not connected with the secondary schools. He may then enter a university directly, or after a year or two more of preparation present himself as a candidate for one of the great engineering schools.

Most of the universities now have connected with them institutes of applied science. These institutes do not grant degrees but give diplomas showing satisfactory completion of the required courses. Some of these places visited by the writer compare favorably with American engineering schools.

The students with more means or greater ambitions in the field of applied science usually devote one or two years to intensive preparation for the entrance examinations of the "great schools" as the French term them. These examinations, partly written and partly oral, have a very advanced mathematical requirement; otherwise they cover the same field as ours, though much more thoroughly.

These schools insist upon an extremely high passing grade for the entrance examinations. From the point of view of the school the degree of selection that it obtains among the

(Continued on page 62)

ENTRANCE TO ECOLE CENTRALE

RESEARCH AT THE INSTITUTE

By PROF. H. M. GOODWIN, '90
Professor of Electrochemistry, Massachusetts Institute of Technology

In the series of articles on "The Laboratories of the Institute" published in the preceding numbers of this journal, attention has been called to the special laboratories devoted exclusively to research. It will not be necessary, therefore, in discussing "Research at the Institute" to consider in detail matters pertaining to equipment. Attention will be directed rather to a consideration of the causes which have lead up to present research activities, and to some of the more important pieces of work which are now under investigation. The Institute is so little given to broadcasting its various activities that it is not surprising the public is ill-informed regarding the character and extent of the research which is being carried on within its walls.

The Institute's reputation rests primarily upon that of its great body of alumni, whose training has consisted for the most part of a four-year undergraduate course, and in the future it will continue to rest in large measure upon the quality of the instruction given and the standard maintained in this course. Nevertheless, if the Institute is to retain its position of leadership as the first technological school in the country, it must go farther than this and provide adequately not only for undergraduate instruction, but also for graduate instruction, which implies ample opportunities and facilities for carrying on research in all its departments. The rapidly increasing number of graduate students coming to the Institute from all parts of the country and from abroad, to pursue courses leading to higher degrees, makes this imperative.

Research, as carried on in universities and technical schools, is inseparably connected with the work of their graduate departments. Only within comparatively recent years has the graduate school of the Institute become a vital part of its organization, and with its growth has come a corresponding development of research. How rapidly the graduate school has grown in recent years may be judged from the fact that the total registration of students working for high degrees has increased from 39 to 327 in the last ten years, and the greater part of this increase has taken place during the last three years. At the present time, there are 264 students registered for the Master's degree and 63 for the Doctor's degree.

Although the Corporation announced as early as 1872 that opportunities were offered to properly qualified students to pursue studies leading to the Doctor's degree, it was not until 1907, thirty-five years later, that the first student qualified for this degree. The Master's degree was first awarded in 1886, and in each subsequent year a few candidates usually fulfilled the requirements, but the total number of degrees conferred from 1886 to 1906 was only eighty-one. It would be erroneous to conclude from this, however, that during this period the Institute contributed nothing to research. Reference to the Proceedings of the American Academy, to the Technology Quarterly (published from 1887 to 1908), and to other journals shows that a number of important investigations were carried out in the Institute laboratories. In the mechanical engineering laboratories, valuable data on the strength of materials were accumulated by Professor Lanza and members of his staff. Under the direction of Professor Richards and members of the mining engineering department, important researches on ore dressing and allied subjects were carried out in the Cummings laboratory. From the Kidder chemical laboratories many papers were published by Professors Crafts, Drown, Norton, Noyes and others, while from the Rogers laboratory of physics, a long series of "Contributions" began to appear as early as 1874. It is interesting to recall that many of the earliest experiments on telephony and the microphone, were carried out in this laboratory by Professor Cross and his students, while the researches on the viscosity of gases and thermo-electricity of Prof. Silas W. Holman were recognized of fundamental importance.

Valuable as many of these early researches were, it must be admitted that during the first twenty-five or thirty years after its foundation, the Institute's most important contribution to science was not research, itself, but rather the training of men who were later to take their place among the leading investigators of the country. The contributions of Pickering, Holman, Noyes, Hale, Calkins, Whitnet, Abbot, Burgess and Coolidge to astronomy, astrophysics, physics, chemistry, biology and applied science are striking evidence of this fact.

The first real impetus to the development of organized research and of a graduate school at the Institute is due to Dr. Arthur A. Noyes, who, largely through his own efforts and contributions, established in 1903, the Research Laboratory of Physical Chemistry, and became its first director. This laboratory at once attracted students who desired to work for the Doctor's degree in the field of physical chemistry. A strong staff was built up, whose teaching duties were limited

THE TECHNOLOGY SERIES

Unfortunately, Tech men can never avail themselves of every advantage their Alma Mater has to offer and many alumni, who for a period, have been under her guidance have never seen the new plant and have no way of knowing their Alma Mater's increased sphere of activity. This year, THE TECH ENGINEERING NEWS is making a special effort to ameliorate this situation in presenting this series of articles on the new Technology, its business management, the work carried on in the laboratories, and the plans for the future. This series, of which this article is the eighth has been prepared by men thoroughly familiar with the phases they treat upon and is as follows:

THE TECHNOLOGY BUILDINGS ..... October
F. J. Whiting, Editor, Stone & Webster Journal.

THE GROUNDS AND THEIR DEVELOPMENT ..... November
H. J. Carlson, President Alumni Association.

THE BUSINESS ADMINISTRATION OF THE INSTITUTE ..... December
H. S. Ford, Bursar.

THE POWER SYSTEM OF THE INSTITUTE ..... January
A. S. Smith, Superintendent of Buildings and Power.

THE ENGINEERING LABORATORIES ..... February
Prof. E. F. Miller, Head of Department of Mechanical Engineering.

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THE PHYSICAL LABORATORIES ..... April
Prof. C. L. Norton, Head of the Department of Physics.

RESEARCH AT THE INSTITUTE ..... May
Prof. H. M. Goodwin, Professor of Electrochemistry.

PLANS FOR THE FUTURE ..... June
To be announced.

to seminars and a few graduate courses, thus permitting its members to devote the larger part of their time to research. The activities of this laboratory may be judged of from the fact that it has published over one hundred and fifty papers and graduated thirty-eight students with the degree of Doctor of Philosophy. A number of these men are recognized today as among the leading physical chemists of the country. Since Dr. Noyes resigned in 1920, to assume the directorship of the Gates Chemical Laboratory at the California Institute of Technology, the laboratory has been in charge of Prof. Frederick G. Keyes. Under his able leadership it has continued to prosper, and to attract a large number of students. At present its activities include four large fields of research, namely:

(*a*) Electro-chemical problems, and general work in connection with the Ionic theory;

(*b*) Chemical equilibrium and heats of reactions;

(*c*) Investigations on the electron structure of crystals by means of X-ray reflection; and

(*d*) Kinetic Theory Studies.

It would be interesting to describe the researches under each of these divisions but lack of space prevents; three, however, which are of especial interest, and which illustrate the way in which the Institute laboratories are coöperating with other research organizations, should be mentioned.

1. In 1919, the Research Laboratory of Physical Chemistry was invited by the United States Bureau of Mines to participate in investigations connected with the improvement of the processes for the extraction of helium to be used in the military service of the country. Part of this work is being carried out in the Research Laboratory of Physical Chemistry and part in the Rogers Laboratory of Physics. The work has involved the determination of the physical properties of the gases accompanying helium in the natural gas, whose helium content amounts to only 0.86 per cent. The investigations have demanded the development of low temperature facilities and technique, and a study of the low temperature thermometric scale. Three papers have been published and more are to follow.

2. Steam turbine practice has reached the point where data are required in connection with the properties of steam at high temperatures and pressures. The present state of our knowledge regarding properties of steam prompted a meeting, under the auspices of the American Society of Mechanical Engineers, in June 1921, of a number of the scientific men and engineers of the country. A program of investigations was recommended and a committee of the American Society of Mechanical Engineers selected to administer funds necessary for the successful prosecution of the work. The investigations are to be carried out by the United States Bureau of Standards, the Research Laboratory of Physical Chemistry, M. I. T., and the Harvard Engineering School. The portion of the work to be carried out at the Institute concerns the study of the vapor pressure curve to the critical temperature, as well as measurements of the liquid specification volumes and the entire superheat region, to a temperature of 500° centigrade or over 900° F.

3. Important progress has been made concerning the fundamental properties of substances in the gaseous and liquid states. This work has led to a satisfactory explanation of viscosities as a function of the density in both the gas and liquid phases. In connection with this work facilities for the production of liquid air have been perfected, and it is hoped that before long an adequate supply of liquid hydrogen will be available for extending some of the investigations concerning fundamental properties.

The establishment of the Research Laboratory of Physical Chemistry was the beginning of the development of other laboratories devoted exclusively to research. In 1908, the Department of Chemistry established a second research laboratory, known as the Research Laboratory of Applied Chemistry, under the direction of Prof. W. H. Walker. The immediate purpose of this laboratory was to bring the Institute into closer touch with the industries by offering facilities for the solution of problems which they themselves were unable to solve. A staff of research assistants working under the supervision of the director undertook the solution of problems presented and from the fees received the laboratory was enabled to investigate other scientific and technical problems in which it was interested. Seventy-seven papers have been published as a result. At present the laboratory is a part of the Department of Chemical Engineering and is under the direction of Prof. R. T. Haslam. The particular fields of research upon which attention is being focused are the following:

(*a*) Lubrication and Lubricants with reference first, to their property of "oilness" and second, to the manner in which this property affects the action of oil in bearings. The investigation involves the determination of the coefficient of static friction of lubricants of various compositions;

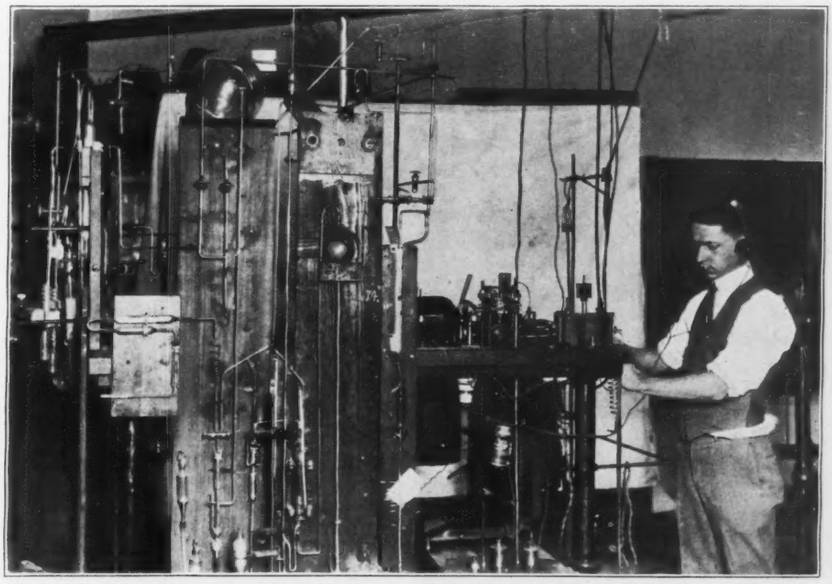
(*b*) Under-water corrosion, and acid corrosion;

(*c*) Applied colloidal chemistry, in particular the stabilization and breaking of oil and water emulsions, and the use of solid absorbents for decolorization and purification of gases;

(*d*) The quantitative determination of the reaction velocity constants of combustion reactions, and their relation to one another.

Research in chemistry is not by any means confined to that carried out in these two research laboratories. Other laboratories of the department are actively engaged on research problems; this is particularly true of the division of organic chemistry, in which many students major for their doctor's degree. The two largest programs of work in this field, under the direction of Prof. James F. Norris are, first a

(*Continued on page 58*)



APPARATUS FOR STUDYING GASES ACCOMPANYING HELIUM IN NATURAL GAS

WILLIAM I. WYMAN

By HON. KARL FENNING
Assistant Commissioner of Patents

THE rapid growth of the United States Patent Office in the past few years has been largely due to the efforts of Mr. William I. Wyman. The fact that he is a graduate of Technology makes a short sketch of his life a very fitting introduction to this article.

William I. Wyman, although not directly engaged in technical work in its narrow sense, does work which has a real influence in the technical world. He was born in Boston, Massachusetts, and, while a clerk in the Boston Post Office, entered the Massachusetts Institute of Technology. He continued his employment in the postal service, working eight hours a day late afternoons and nights, up to his senior year. In his freshman year he received a credit in every subject upon the semi-annual and final reports. He qualified for and graduated in 1900, in Course XIII, Naval Architecture and Steam Engineering. Upon graduation he entered the Bath Iron Works as a ship's draftsman, and not long thereafter entered the Navy Department, Bureau of Construction and Repairs, as ship's draftsman, where he specialized in computations and scientific work. He entered the Patent Office in September, 1903, passing through all the grades of assistant examiner, and has been Chief Clerk of the Patent Office since August, 1919. As assistant examiner he had charge of varied branches of the technical arts, his last assignment being in Metal Founding and Iron and Steel Metallurgy. During this period, by pursuing courses after office hours, he obtained the degree of LL.B. from the National University, and that of Master of Patent Law from George Washington University, and was admitted to the bar of the District of Columbia.

The Patent Office, in addition to being a technical organization, is a large business institution, receiving in fees and for services about $3,000,000 per annum, handling and selling publications to the value of a quarter of a million of dollars a year, and rendering services to inventors and manufacturers which bring in almost $200,000 additional in fees each year.

Mr. Wyman, as Chief Clerk of the Patent Office, has control, under the authority of the Commissioner, of the administrative work of the office, a majority of the eleven hundred employees coming under his supervision.

When Mr. Wyman took charge of the administration of the business side of the office, many of its methods of doing business had been unchanged for forty years and, in addition, he inherited a condition arising from the war in which the personnel was disrupted. There had been frequent resignations, and consequently the force was untrained to a great degree. This was at a time when there was an increased receipt of business to an overwhelming extent and unprecedented in the history of the office. He was obliged to take measures to improve the almost destroyed morale, due to low salaries, a lack of opportunity for promotion, an increased cost of living, and pressure of the increasing work. On presentation to Congress of the critical condition of the office, a deficiency bill was passed which slightly increased the force and alleviated in a measure the conditions, although the relief was nowhere proportionate to the increase in demands upon the office. In order to make effective the functions of the office, drastic reforms in methods and means of doing work were instituted, and in the course of a year appreciable improvement could be seen from the measures adopted.

WILLIAM I. WYMAN

The Patent Office sells, at ten cents each, about two hundred thousand printed copies of patents each month. In the latter part of 1919 and the early portion of 1920, it took about two weeks to procure a copy of a patent, while today they are frequently delivered the same day the order is received; the execution of orders for copies out of print was delayed about six months, while today they are reprinted in less than four weeks; in the former period, assignments were not recorded for over four months, while today they are recorded within one month.

The methods of doing business in several of the divisions were completely and radically changed; drastic reorganization of the method of receiving and keeping account of fees and their disbursement was effected, and, most particularly, steps were taken to design and erect modern and improved equipment for the special needs of the Patent Office. In the three fiscal years from June 30, 1919, to June 30, 1922, the business of the office increased from forty to seventy-five per cent in the various branches, while the number of employees increased by only six per cent. Nevertheless, the work in the first-named year was almost in a condition of chaos, while the functions of the office on the administrative side are running now with almost perfect smoothness. As stated in the report of the Secretary of the Interior, at the end of his first year's administration, with reference to the Patent Office:

"The administrative side of the Bureau was kept functioning and was prevented from being swamped by the overwhelming mass of increased work through the institution of radical reforms and by the introduction of new methods to make more effective its organization. These changes, both in variety and volume on the one hand, and in consequences vital to the service on the other, were probably the most notable ever applied in the history of the office since the memorable administration of Commissioner Fisher in 1870, who, by the way, introduced the merit system in this country for entrance into the government service."

The Patent Office is a complex busi-

(*Continued on page 68*)

THE DESIGN AND MANUFACTURE OF INSULATORS

By K. A. HAWLEY
Chief Engineer Locke Insulator Corporation, Victor, N. Y.

Small pin type insulators had been made for many years for use on telephone and telegraph lines so that the elements of design and shape had already been worked out at the time that the demand for insulators arose for transmitting electric power. Nearly all of these early insulators were made of glass as it afforded the most available material for such work. Porcelain had been used in small quantities as early as 1860 but difficulties of manufacture and indifferent quality caused its use to be abandoned.

An investigation of the use of local clays and of porcelain for the manufacture of small insulators was revived by Mr. Locke in 1890 as he had observed that on telegraph lines, the glass surface seemed to hold moisture more than porcelain surfaces. His company, for the manufacture of porcelain insulators in earnest, was organized about three years later at

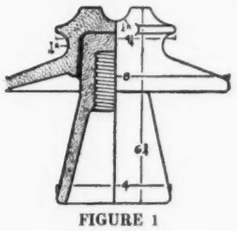


FIGURE 1

about the time that the demand for high voltage insulators was beginning. Several of the insulators which he first made are still manufactured.

The demand for insulators of more than one piece for higher voltages was first met by making the insulator in two parts. These pieces were joined by fusing them together in firing. This construction was quite satisfactory but has been abandoned because it is not quite as reliable as other methods of assembly now used. With still larger sizes, the glazing of the parts together was found impractical so that the use of Portland cement was early adopted, and has been in constant use since about 1900. At about that time, the first 60,000-volt transmission lines were being built in the West. The first insulators which were used for this voltage consisted of a porcelain top or hood with a glass center or skirt, the two parts being cemented together. Many of these insulators are still in service, most of them having been removed from the higher voltage lines and placed upon 11,000 and 22,000-volt circuits in locations where a large insulator would be required. The reason for the use of the glass center was to afford a slightly higher puncture strength than could be obtained with the porcelain of that time.

These insulators were soon followed by larger ones of three and four porcelain parts, thousands of which are still in use, many being made twenty years ago. All of them were built up of porcelain averaging about three-eighths inch thick and none over one-half inch as that was the limit of porcelain thickness which could be produced satisfactorily at that time.

Fig. 1 shows an elementary two-part insulator of early design which is still in very large demand for use in places where there is an unusual amount of dirt or salty fogs from the ocean.

In Fig. 2 is shown a four-piece insulator which is also still being made in large quantities for use on 66,000-volt circuits under somewhat similar conditions.

Insulators of this type on test will show a large amount of corona at voltages well above that which they carry in service but appreciably below the arcover voltage. It was believed that this corona was a cause of porcelain depreciation and that an effort should be made to design insulators so that the corona would not appear at such low voltages. This was accomplished by making thicker parts, for the art of porcelain manufacture had progressed to the point where this was possible. The size of the cemented joints was also increased in proportion and the parts of the insulator were made so that minimum of cement was exposed to view. All of this greatly reduced the corona on the insulator so that it would not be visible up to about ninety per cent of the dry flash-over voltage. It is now felt that this idea was carried further than was necessary and the tendency in insulator design is back toward the more elementary types.

There are other objections to the large four-piece shown in Fig. 2. All surfaces of an insulator, sooner or later, become coated with dirt which may be in the air. In the open country where the air is relatively clean, the effect of this is not noticeable but in places where there is an unusual amount of dirt, the hidden surfaces become coated. The driving rains do not get into the upper parts of these recesses so that they ultimately become useless on being dampened by fogs and mist. The more open type of insulator with fewer parts will give more satisfactory service under dirty conditions, even though the leakage distance over the surface of the porcelain from the conductor to the pin is greatly reduced. There are many places on record where the early insulators have been exchanged for the more modern designs with an appreciable reduction in the percentage of arcovers during foggy weather.

It is obvious that if all this leakage distance is not necessary for the dirty localities, it is not necessary for the cross-country transmission lines where there is a relatively small amount of dirt. The more open type of insulator, should, therefore, be used in both places.

To fill this need a three-piece insulator rated at 66,000 volts was developed. The leakage distance over this insulator is thirty per cent less than over the old style four-piece. Nevertheless, from its shape, this insulator has proven more effective than the older type. The porcelain parts are

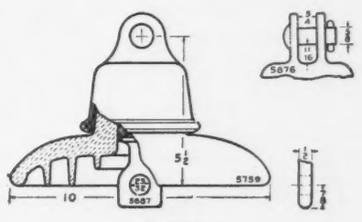


FIGURE 3

much thicker than with the old insulator so that the resistance to puncture is greater with the three pieces of porcelain than with the old style with four pieces.

The problem of line insulation for higher voltages than 60,000 and the difficulties of making still larger pin type insulators caused the development of the suspension type insulator about 1906. They were made at that time in two general types. One was developed by Mr. E. M. Hewlett and is still known by his name. This insulator consists of a ball of porcelain with a projecting flange or hood. Holes with curved path are drilled into the ball before firing so that the hardware passes through interlinks, the parts being separated by an insulating wall of porcelain. The other type of insulator, Fig. 3, consists of a plate of porcelain with a hollow head at its center to which are cemented a cap and bolt of metal. Many thousands of the cemented type suspension insulators were made in the next few years only to find that further consideration of details of attaching hardware to the porcelain was required. Nevertheless,

(*Continued on page 70*)

MEASUREMENT OF STRUCTURAL STRESSES

By MAJ. F. JOHNSTONE-TAYLOR
British Army

An instrument has recently been designed for the purpose of recording rapidly the varying stresses in a structure, such as those produced, for instance, by a train travelling at high speed over a bridge, or in the hull or other parts of a ship at sea, in fact, the stresses in any structure produced by moving loads. The necessary magnification can be obtained with a beam of light reflected from a small oscillating mirror, whose weight is negligible, the inertia of the moving parts thus being reduced to a minimum.

Fluctuating stresses varying as much as 350 times per second can be recorded under ordinary illumination and high-speed film winding.

The instrument can be used for recording the stresses on a photographic film which passes in front of a vertical slit, or they can be observed on a glass screen provided for visual observation which can be inserted in place of the vertical slit.

It is designed to take a standard film roll such as No. 2 Brownie, but any film about twenty-four inches long and two and seven-sixteenths inches wide may be used.

The value of being able to determine the stresses in bridge members and the like cannot be over-estimated. It must be apparent to every engineer, whether designer, builder or superintendent, connected with such work.

Especially would this be the case in old structures, for by the use of this instrument it is possible to ascertain whether the bridge can be strengthened or whether the stresses are such that would demand its replacement.

Many of the older bridges have redundant members in them, and by any method of calculation the stresses therein are difficult to ascertain, but apart from this, even in well-designed bridges the stresses are difficult to obtain with an assured accuracy, particularly as it is now well known that the secondary or deformation stresses are all of great importance.

It is therefore found that the readings of the instrument rarely agree with those calculated, even if placed on the axis of a member in a truss span.

Instruments of this class have been used for a large number of experiments on bridges in India, in every case the stresses calculated by statics being greater than the recorded stresses. This is no reflection on the accuracy of the instrument or the validity of the calculations. There is a good reason for the discrepancy.

When a live load comes on to a bridge a certain amount of work is stored up in the structure. It is stored up in two ways, one by producing longitudinal deformation in the members themselves and the other in producing bending deformation in every part of the bridge. In the aggregate these deformations produce the deflections in the span and the observed deflection is a measure of the work done.

As the axial deformation in a member of a span is a measure of the total stress in it and as statics take no account of elasticity, it follows that the static calculations must be greater than the actual, because they include the deformation stresses.

It is found in every case that the deflection as calculated by the "Principle of least work" based on Castigliano's theorem is always greater than the observed deflection. If the stresses in a member as calculated by statics be multiplied by the ratio of the observed deflection over the calculated deflection the result will approximate very closely to the observed axial stresses in the member.

Thus calculated stresses may be the means of condemning a bridge, whereas the actual stresses as recorded on the instrument may give the bridge a new lease of life.

The general construction is shown in figures 1 and 2. The vertical slit marked (*a*) has projected on it two images of an illuminated horizontal slit marked (*b*). One of these images is reflected from a mirror (*c*) which oscillates on a horizontal axis and is thus able to form an image of the horizontal slit (*b*) at the back of the vertical slit (*a*), the intersection forming a spot of light.

The pivots of mirror (*c*) are attached to a leg (*e*). This leg is fixed to the main body of the instrument at its upper end where its section is reduced to render it flexible in order that it can oscillate when the milled nut (*e*) is screwed back.

(*Continued on page 76*)

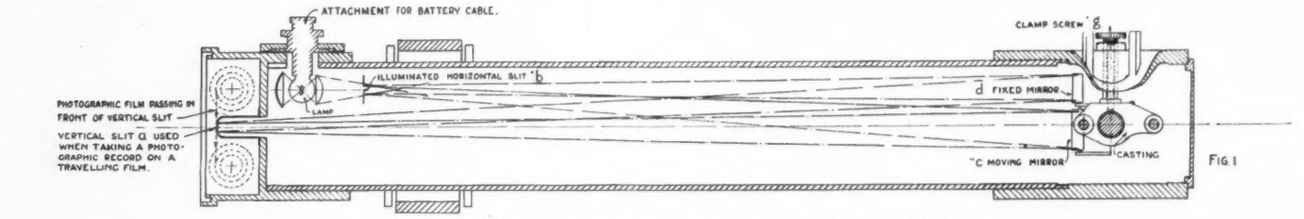

ATTACHMENT FOR BATTERY CABLE.
CLAMP SCREW g
ILLUMINATED HORIZONTAL SLIT b
d FIXED MIRROR
PHOTOGRAPHIC FILM PASSING IN FRONT OF VERTICAL SLIT
LAMP
VERTICAL SLIT a USED WHEN TAKING A PHOTOGRAPHIC RECORD ON A TRAVELLING FILM.
c MOVING MIRROR
CASTING

FIG. 1

PLAN SHOWING PATH OF LIGHT FROM BOTH MIRRORS.

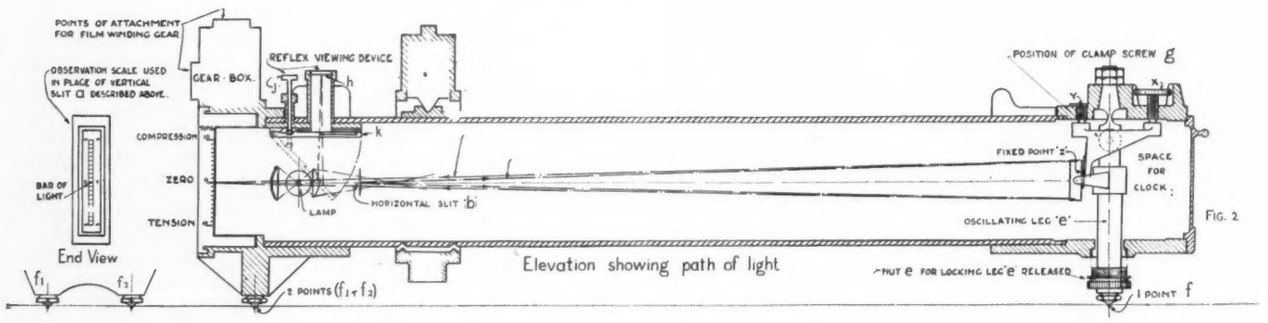


FIG. 2

FLYWHEEL EXPLOSIONS AND THEIR PREVENTION

By F. B. TOLSTED
Tolsted, Fonda, Inc., Washington, D. C.

Statements have been made frequently that exploding flywheels cause more damage than exploding boilers. Whether or not this statement is true, it is true that state and city regulations practically disregard flywheels, but we have boiler regulations wherever we turn. It must be only a question of time when regulations and laws will protect lives and property against flywheel accidents, as they now protect them against other hazards.

The limiting speeds for flywheels and pulleys of the best design have been determined theoretically and by tests, the two sets of figures agreeing very well. We know that a given wheel cannot speed beyond a certain point without giving way; the speed depending, among other things, upon the type of wheel.

Manufacturers have bought their engines and other machinery equipped with flywheels, assuming that the flywheels were safe for the speeds specified. Some purchasers have gone further than this. They have treated their flywheels and pulleys as they would their automobiles and have run them at as high speeds as conditions outside of safety would permit. They have learned that faster working machines, in many cases, increase output and they have speeded up without giving the flywheel a thought.

Nearly all factory men have heard that the belt has a limit of speed beyond which there is disadvantage in going. This has been the salvation of the pulley for it has held down the rim speeds of pulleys. It should be remembered, however, that a split cast-iron pulley, or a flywheel with a flanged joint carrying a belt which runs at 5,000 feet per minute is going altogether too fast. A solid cast iron pulley can only run at about 6,100 feet per minute and still have a factor of safety of ten, which is the figure that should be used in pulley and flywheel work.

Unfortunately, the correct speed for the belt does not always hold down flywheel speeds. For example, one might have an engine direct connected to a line shaft having pulleys, let us say 4 feet in diameter. This engine might have a flywheel ten feet in diameter. The flywheel speed could then be in the neighborhood of 12,000 feet per minute without overspeeding the belts.

There are three types of wheels in common use; the flywheel with a single piece rim, the flywheel with a split rim and with a link joint, and the flywheel with a split rim and with a flange joint. The solid wheel can be used only if the diameter is less than ten feet on account of the difficulties in construction and shipment. The link jointed wheel can be conveniently adopted only where the rim is thick. Since such a rim is not frequently used for belt or rope driving, where such a drive is necessary, a solid or a flange jointed wheel is used.

One can usually get an idea of the safety of his flywheel equipment from the rim speeds. Since, however, the computation of the rim speed requires the multiplication of three figures, namely, the revolutions per minute, the diameter of the wheel, and the constant π, it has been found more convenient to omit π and to think of the safety of flywheels in terms of the revolutions per minute and the diameter. The following products of the revolutions per minute and the diameter of the wheel in feet should not be exceeded, if it is desired to keep the factors of safety at ten or above:

(*a*) For solid cast-iron flywheels 1,937.

(*b*) For link jointed cast-iron flywheels 1,500.

(*c*) For flange jointed cast-iron flywheels 968.

If, in any case, it is found that the product referred to above exceeds the figures suggested for the type of wheel which is operating, a further investigation of the conditions should be made. The diameter is not to be taken as the outside diameter but as the mean diamter of the rim.

From Marks, Kent, and similar handbooks, we may obtain formulæ for centrifugal force which can be finally worked into the following:

Stress in a cast iron-rim $= .0002664\ (RD)^2$.

If we take the accepted figure of 10,000 pounds per square inch as the maximum tensile stress which cast iron is capable of withstanding, and use a factor of safety of ten, we have $1{,}000 = .0002664\ (RD)^2$ or $Rd = 1{,}937$.

A joint in a flywheel is like a riveted joint in a boiler, in that one cannot exceed a certain efficiency. For a flange jointed wheel this maximum efficiency is 25 per cent. Therefore, while we can allow a stress of 1,000 pounds per square inch in a rim of the solid wheel, we should limit ourselves to 250 pounds per square inch in the rim of the flange jointed wheel. Then in this case $250 = .0002664\ (RD)^2$ or $RD = 968$. Because the efficiency of a link joint does not exceed 60 per cent, $600 = .0002664\ (RD)^2$ or $RD = 1{,}500$.

Now, having the speeds of several wheels at which we will have factors of safety of ten, the next question to be determined is the probable bursting speeds. Since the stress increases with the square of the speed, it follows that the wheels can operate not ten times as fast, but the square root of ten times as fast as is indicated by the figures above, before they will actually burst. The square root of ten is approximately 3.16. Therefore the highest speeds which wheels are likely to be able to attain are:

(*a*) Solid, 6,120 feet per minute.

(*b*) Link jointed, 4,740 feet per minute.

(*c*) Flange jointed, 3,059 feet per minute.

In order that you may know the approximate factors of safety of your wheels, the following formulæ may be applied:

For a solid wheel the factor of safety $= \frac{(1937)^2 \times 10}{(RD)^2}$

For a link jointed wheel the factor of safety $= \frac{(1500)^2 \times 10}{(RD)^2}$

For a flange jointed wheel the factor of safety $= \frac{(968)^2 \times 10}{(RD)^2}$

As explained above, the figures given are those for wheels with the best possible design of joint. Therefore, if you make a computation from any of the formulæ above you may be sure that your wheel is not better than the result obtained from an application of the formula, but that it is less good if the design is not of the best.

The engineer who is called upon to investigate a flywheel finds it necessary to measure the wheel very carefully and to make practically a duplicate of the original flywheel drawing. From this he determines the stresses in the various parts of the wheel. Link jointed and flange jointed wheels furnish complicated mathematical problems for him. A few assumptions are necessary. Most of these happen to fall on the side which would indicate the flywheel to be safer than it is, so that when the engineer has made his computation he can only say to you "I know that the stresses are this high but I do not know how much higher they may be. Similarly, I know that the factor of safety is not above this figure."

One assumption which is frequently taken exception to, but which, nevertheless, is justified, seems to fall on the

(*Continued on page 64*)

DUST COLLECTING AND PNEUMATIC CONVEYING

F. L. JORGENSEN
President, The Dust Recovering and Conveying Company, Cleveland, Ohio

Recurring disasters in a wide range of industries have forced recognition of the fact that dust is a dangerous explosive. The United States Department of Agriculture and the United States Grain Corporation have, through a series of pamphlets, been trying to warn industry against dust hazards and to suggest means of control. In one of their bulletins they say, "Dust from grain will explode when mixed with air in proper proportions and ignited by sufficient heat or flame.

The hazards of a dirty and dusty plant are very great. The only safe guarantee against a dust explosion is to practice "good housekeeping" and keep your plant clean at all times. It is your duty to protect not only your property but the health of your employees."

It was in an attempt to alleviate these conditions that the first equipment for dust recovery was constructed. This consisted of a flue from the source of the dust, the fan and the sheet metal centrifugal separator. The action is simple. The current of air carrying the material, such as shavings, etc., passes through fan and is blown into separator. At this point its velocity is lowered and a centrifugal action is developed, precipitating most of the material it carries.

For use on shavings in woodworking plants, and similar needs, the cyclone separator is satisfactory. Some of the dust and fines, however, escape through this separator into the atmosphere, and whenever they may be or become a nuisance or a menace, or when they are valuable and should be conserved, this type of separator should not be used.

To overcome the defects of this, an auxiliary "wet separator" can be installed. When the escaping dust has no value and its collection is necessary to abate a nuisance only, this installation is satisfactory. The escaping air usually passes through a centrifugal water spray, and comes into the atmosphere essentially clean.

The next step in dust collecting has been the development of a great number of special equipments wherein the dust is retained on cloth through which the air is passed. The earliest form of this consisted of a header from which bags are suspended connecting with the dust hopper below. The air escapes into the atmosphere.

This equipment in general is fairly efficient, more so than the metallic collector, and has been in use a good many years in the form of bag houses in smelter plants and elsewhere.

In this type, however, the dust will form a layer on the inside of the cloth filter, filling the fabric of the cloth, choking it, reducing the air movement by increasing the resistance and decreasing the volume handled by the fan. This slows up the entire operation, especially the suction at the dust source.

The time that it takes for this equipment to get choked depends entirely upon the quantity of dust contained in the air. It is a general practice to shake the dust bags once or twice a day, by various methods. This, of course, is a decided disadvantage, being cumbersome and costly. At these cleaning periods considerable dust leaks from the bags into the atmosphere.

It should be noted that in all these installations the fan was between the source of dust and the filter. In other words, the dust-laden air passed through the fan. Explosions of this type of apparatus were rather numerous. At first engineers were at a loss for a satisfactory reason. Then it was suggested that the explosions were possibly often started by sparks ignited by the fan blades striking foreign particles passing through the air.

Accordingly the next improvement consisted in putting the filter before the fan or pump and making this filter self-cleaning. This has been accomplished by one firm in the following manner (see Fig. 1).

The bags, usually in sets of twelve, are hung inside of heavily built, air-tight metal cylinders. A battery of cylinders can contain any number from two up, depending on the conditions to be met and capacities required.

The air or gas, dust-laden, enters and passes up into the bags and out through the filtering cloth, depositing the solid inside the screen. Cleaning the filter bags must be frequent and thorough. About every one or two minutes a current of compressed air, controlled by an automatic distributing valve, shuts a damper and, operating

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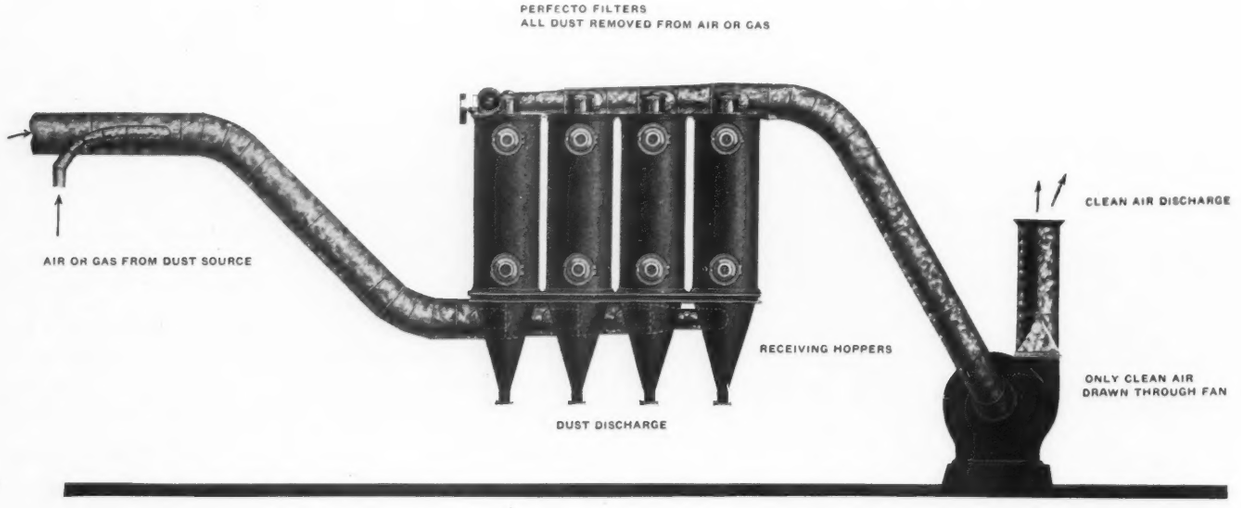


FIGURE 1. THE LATEST TYPE OF DUST RECOVERY INSTALLATION

WIND TUNNEL AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY

By J. R. MARKHAM
Department of Aero Engineering, Massachusetts Institute of Technology

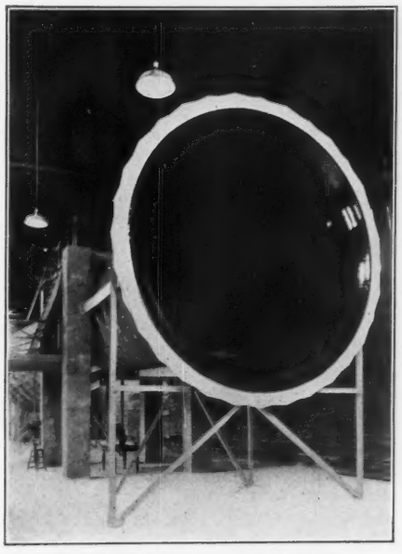
During the past year there has been constructed in Building 20, the Aeronautical Laboratory of the Institute, a new wind tunnel. Of circular cross section throughout it has an overall length of eighty-one feet and an experimental chamber seven and one-half feet in diameter. It is of the Venturi type, after the design of Prof. E. P. Warner; with respect to size and velocity it is one of the largest in the United States.

In order to properly house and construct the tunnel, it was necessary to remove all the remaining partitions of the hangar, to build concrete foundations for the tunnel supports, a huge pedestal for the driving motor, and to replace the former wooden floor by one of concrete. With this work completed the actual construction of the tunnel went ahead rapidly. The Service Department deserves much of the credit for its energy and coöperation.

For the purpose of this exposition the tunnel may be divided into three sections, the entrance cone or air intake bell, the experimental chamber or throat, and the exit cone.

The entrance cone has a length of 21 feet and the diameter at the large end is 15 feet. Its surface was generated by revolving an ellipse of semi major and semi minor axes of 21 feet and 3 feet 9 inches respectively, about the axis of the tunnel. The frame work of this section consisted of built up circular rings of white pine which were notched to carry 32 longitudinal pieces. These ribs were made of selected whitewood stock, lap joined and cut from a template representing the generating surface of the entrance cone. The size and weight of these numbers made it necessary to assemble this section in place. The inside of this entire section was then covered with wire lathe as reinforcement for plaster. The plaster was applied first on the inside of the tunnel and then the outside was backed up to a depth of 2½ inches. A final coat of high-grade white cement was applied to the inside and the exact curvature of the tunnel was obtained by sweeping this covering with a template, cut to the required curve and mounted so as to swing about the axis of the tunnel. The plaster was allowed to dry thoroughly, was then given a coating of shellac, and later stained and varnished.

The experimental chamber is a cylinder 13 feet long and 7½ feet in diameter and is made of 3-inch by ⅞-inch matched whitewood, fastened directly to the rings. This section was built on the floor and hoisted into place as its weight and bulk were not excessive. The exit cone is a right circular cone and has a length of 47 feet. The diameter increases from that of the throat to 14 feet 3 inches. Its construction is similar to that of the entrance cone, except that it is sheathed with ⅜-inch whitewood, beveled,



THE EXIT CONE OF THE TUNNEL

doweled and glued to form strong air-tight joints. A longitudinal opening ¼-inch wide was allowed at intervals of 4 feet on the circumference to compensate for expansion.

The three sections were securely tied together by means of the ribs of the entrance and exit cones overlapping and notching into the rings of the experimental chamber. The interior of the throat and exit cone was finished smoothly and oiled and varnished to preserve the wood.

The entire tunnel, with the exception of the throat is supported by a keel and side pieces of 8-inch by 2-inch hard pine to which the rings are secured by brackets, and the angle iron supports by bolts. The supporting truss is the W type designed to relieve the tunnel of longitudinal tension and compression. The experimental chamber rests on channels embedded in four huge concrete columns.

The power equipment was designed by the General Electric Company. It consists of a 135-h.p., 2,200-volt synchronous motor, a 5.5.-kilowatt direct current exciter, and 87.5-kilowatt direct current generator, a 100-h.p. direct current motor and a direct current pilot generator. The synchronous motor supplied from the Institute power plant drives the direct current generator and exciter, the latter supplying the field currents for each of the units. Current for the direct current driving motor is supplied by the direct current generator, and the pilot generator is driven from the shaft of the direct current motor by a "Link Belt."

The field voltage of the units is controlled by a voltage regulator operating across the exciter field rheostat, which keeps the voltage constantly at 125 volts.

The speed of the driving motor is controlled by the Ward and Leonard system in which changing the field current of the direct current generator changes the speed of the direct current motor. For any setting of the direct current generator field rheostat the Ward and Leonard system of control produces almost constant speed in the direct current motor, but finer regulation of the driving motor speed is obtained by the addition of a speed regulator in which a relay, operated by the current from the pilot generator, cuts in and out rapidly a small amount of resistance in the direct current generator field.

Directly connected to the shaft of the driving motor by a long extension is a four-bladed variable pitch propeller 14 feet 1 inch in diameter, especially designed for wind tunnel operation. The shaft is mounted in two ball bearings, a self-aligning radial bearing in the center and a thrust bearing at the propeller end.

The end of the shaft was turned to fit a standard "Liberty" propeller hub. The support for the shaft is a simple frame of angle iron and tie rods. All the measurements of wind speed made to date have been made without the honeycomb in the tunnel. The highest speed measured was 95.5 miles per hour. This speed, however, consumed only about 82 per cent of the rated horsepower of the electrical equipment and was the limit to which the gauge used would register. The tunnel was designed to give a speed of 85 miles per hour with the honeycomb in place and though the decrease in velocity due to the honeycomb is between 15 and 20 per cent there is no doubt but that the designed speed will yet be attained.

MONTHLY NEWS

Ore Classification Problems. In the study of ore classification problems; being conducted at the Moscow, Idaho field office of the Bureau of Mines, by A. W. Fahrenwald, ore dressing engineer; a number of experiments will be conducted, using a small single spigot classifier 2¼ inches in diameter (glass tube) capable of being readily adjusted to lengths between 8 and 13 inches. This classifier is constructed so as to permit the use of constriction plates of various designs. The experiments will be made with the object in view of determining approximately the factors necessary to know in order to design a multiple spigot classifier to operate with automatic discharge. The design contemplated, which is a modification of the Elder Hydro-balance principle, will permit regulation of the density of the teter bed in any chamber and discharge of the sands at that density. A series of four runs, using the single spigot classifier, has been completed, in which classified sands were discharged at four different densities.

The theory of classification seems to be well worked out, but mill men seem not to understand just where and how classification is done. It, therefore, appears that metallurgical improvement along this line will come through a development of the mechanics of classifiers. Close classification, *i.e.*, classification under maximum hindered settling conditions in combination with screening as a method of concentration, would appear to offer considerable possibilities on certain types of ores, particularly on the coarser sizes; the Bunker Hill ore being an ideal one for such a study.

Permissible Storage Battery Locomotives. The design, construction, inspection, and test for permissibility of a storage-battery locomotive outfit, intended for use in gaseous mines, represents a large amount of work, first on the part of the locomotive manufacturer and secondly on the part of the Interior Department. Detailed information of the first investigation of this nature is presented in Serial 2449, by L. C. Ilsley, electrical engineer, and H. B. Brunot, junior electrical engineer, which may be obtained from the Department of the Interior, Bureau of Mines, Washington, D. C.

The Fourth Annual Traffic Convention of the American Radio Relay League was held on March 31 at M. I. T. As has been the custom in past years, the Radio Society of Technology acted as hosts.

The traffic convention, which was held in the afternoon, brought out the fact that many messages that were being handled as traffic, were in reality absolutely meaningless and only caused congestion. The convention recommended that stations refuse to handle this type of message and thus clear up a great deal of unnecessary congestion.

The banquet, which came in the evening, was served in Walker Memorial. Prominent among the after-dinner speakers was Hiram Percy Maxim, President of the A. R. R. L. Mr. Maxim, in opening his speech, complimented IXM very highly on the quality of performance which it had succeeded in attaining during last winter. He also said that IXM was the foremost university station in the country. Mr. Maxim brought with him news from the Washington conference and passed on to the radio fans present the important discussions which took place there. The keynote of his speech was the need of coöperation between the amateur and the broadcast listener. He also stressed the importance of preserving "quiet air" from seven-thirty to ten every evening.

Kenneth B. Warner, Editor of *Q.S.T.* announced the redistribution of wave lengths in the amateur section. They are as follows:

Straight C. W., 150–158 meters; amateur phone, 158–164 meters; I. C. W., A. C. C. W., 164–176 meters; spark, 176–200 meters, straight C. W., 200–220 meters. Operators with straight C. W. transmitters are permitted to operate over the entire band of amateur wave lengths. The requirements for the amateur extra first grade license were announced at this time. To hold such a license an amateur must receive at the rate of twenty words per minute. He must have had at least two years' experience and must have a theoretical knowledge of radio equivalent to that required for a commercial license, leaving out that part dealing with arcs.

Radio Development in Brazil. Communication by means of radio telephony has been established between Sao Paulo and Rio de Janeiro, following earlier unsuccessful attempts which were said to have failed on account of atmospheric difficulties, says Assistant Trade Commissioner M. A. Cramer, in a report to the Department of Commerce.

Improvement in Street Lighting. Improvement in street lighting has made very satisfactory progress in the cities of the Western States during the past year.

Noticeable among these improvements has been the increase in the interest of the small towns in the movement. In one district alone, containing a population of one and one half million people, over two million dollars has been appropriated for ornamental street lighting. Low intensity overhead fixtures at street intersections, in many cases the only type of illumination existing in rapidly growing towns, are being replaced by ornamental single lamp units. The modern units present a marked contrast to the inefficient multi-lamp clusters at one time widely used for lighting business districts.

The design and efficiency of street lighting units has shown a remarkable efficiency in the past few years. The incandescent electric lamp seems to have reached a period where striking changes are rare. Yet a new 2,500-c.p. gas-filled incandescent lamp has been placed on the market which is the most powerful light source ever made available for the electric lighting of streets.

It is particularly adapted to business street lighting in important, congested districts. It is also possible from this light to obtain nearly twice as much light from a single incandescent source as could be obtained before.

The trend in design of street lighting units is commendable. Most units show the results of efforts to combine a pleasing appearance with effective light control. Most striking of all, perhaps, is the tendency toward a higher mounting in all branches of ornamental lighting.— *Journal of Electricity and Western Industry.*

An official United States Government Building has been built at Rio de Janeiro for the Brazilian Centennial Exposition and at the close of the centennial will be used as the American Embassy. Permanent buildings of a somewhat similar nature have also been erected by Belgium, France, Great Britain, Japan, and Norway on the Avenue of Nations. The building was erected under the direction of Col. D. L. Collier, Commissioner General to the Brazilian Exposition and was constructed by Dwight P. Robinson & Company of New York at a cost of about $300,000. It was designed by Frank L. Packard, '90, of Columbus, Ohio.

The building was built in the Portuguese style of architecture and is a two-story structure built around a patio, or open court, containing a fountain and a tropical garden surrounded on all sides by a wide corridor with arched openings. All the rooms open on the cloisters surrounding the patio, the walls of which are finished in soft buff Caen stone, with the frieze and soffits of the overhanging cornices and the tile insert of the walls in high color.

Construction operations began with the breaking of ground on March 23, 1922; the corner stone was laid in June by Madame Epitacio Pessoa, wife of the Brazilian President, and the building was dedicated September 7, 1922 by Secretary Hughes and the American Commission to the Exposition.

The building harmonizes well with the Brazilian setting, and in its permanent position on the Avenue of Nations is expected to become one of the distinctive edifices of the capital.

UNITED STATES OF AMERICA
GOVERNMENT BUILDING
RIO DE JANEIRO BRAZIL
FRANK L. PACKARD ARCHITECT. DWIGHT P. ROBINSON & CO. INC. CONSTRUCTORS
Courtesy Dwight P. Robinson Co. Inc.

BOOK REVIEWS

Belt Conveyors and Belt Elevators, by Frederick V. Hetzel. John Wiley & Sons, New York, 1922. Cloth 6x9 inches, 333 pp., illustrations, diagrams, tables, $5.00.

In this book the author aims to explain principles and reasons for doing things rather than a restatement of trade advertisements. The author has had thirty years experience in the design, manufacture and erection of conveying and elevating machinery, and gives the results of these years of experience in a form useful to the consulting engineer who advises proper machinery to do the work, to engineers and draftsman who are engaged in designing such machinery and also to students in technical schools and colleges.

Metals and Their Alloys, by Charles Vickers. 800 pages, 6¼ × 9¼ inches, 110 illustrations. Published by Henry Carey Baird & Co., Inc., 2 W. 45th Street, New York City. Price $7.50.

This is a thoroughly practical book, partly based on the work of William J. Brannt on Metallic Alloys, and is descriptive of the best American practice in dealing with metals and their alloys. The author is an experienced and reliable foundry authority, and is an extensive contributor to the technical press. This volume contains besides the alloys, a comprehensive and authoritative section on the occurrence of the metals in ores and their extraction.

It describes the chemical as well as the physical properties, and the various applications of the alloys in the arts and industries. Information is given on the various alloys of aluminum and the precautions to be observed when casting so as to avoid cracking. A complete chapter on die castings, descriptions of the casting machines in use, and analyses of the best-suited die alloys is included. The alloys of magnesium and other metals of the electronic group are given, and the care to be taken when melting and alloying this family is also cited. Methods for the analysis of nearly all the alloys are also described.

The alloys have been placed in twelve distinctive groups, according to the metal used as base, and are as follows: (1) aluminum alloys, (2) bronzes, (3) brasses, (4) nickel alloys, (5) tin alloys, (6) lead alloys, (7) amalgams, (8) alloys of the precious metals, (9) fusible alloys, (10) iron alloys, (11) magnesium alloys, (12) zinc alloys.

The book serves as a complete and practical guide for the metal worker, a convenient source of information to the student of metallurgy and to the engineer who must select alloys suitable for his purpose. Included are hundreds of tables giving the composition, properties, and analysis of alloys of every description and for every conceivable purpose.

UNITED STATES CIVIL SERVICE EXAMINATION

The United States Service Commission announces the following open competitive examination:

Checker Draftsman (Architectural). The receipt of applications will close May 15. The examination is to fill a vacancy in the Public Works Department, United States Naval Station, Pearl Harbor, Hawaii, at eight dollars a day, and vacancies in positions requiring similar qualifications. The appointee to the position at Pearl Harbor, will receive in addition to the salary, an allowance of ninety-six cents a day while employed at the station. He will be furnished transportation to Honolulu.

The duties are as follows: Charge of the drafting and checking work on one or more important projects, including responsibility for engineering or architectural features of the design, or other comparable supervisory work.

Competitors will not be required to report for examination at any place, but will be rated on their education, training, and experience, on a scale of of one hundred.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or secretary of the board of United States civil service examiners at the post office or customhouse in any city.

EDITORIALS

THE IMPORTANCE OF ENGLISH

In the summer of 1917, Professor Pearson, on behalf of the Department of English and History, wrote to a number of prominent Technology Alumni asking their views concerning the importance of English in professional and business life. Under the term he included, of course, the ability to write with force and clearness, to speak readily and without embarrassment, and to get pleasure and profit from the reading of real books.

Despite the turmoil of that hectic summer, a large proportion of those men replied, many of them with fullness. These answers are practically unanimous in urging better training for young engineers and executives in writing — including the preparation of reports — in speaking, and in the humbler mechanics of human intercommunication, such as spelling and penmanship.

Nearly all the writers seem to appreciate, however, that the four years of the Institute course is too short a period into which to crowd all the technical subjects regarded as essential and, in addition, this much-desired training in English. Many indicate a few of the difficulties — though none visualize them all — and some fear that a solution may be impossible.

A problem so generally considered vital to the success, both material and immaterial, of Institute graduates must not be regarded as insoluble. Its perplexities, however, are increased by two factors over which Technology has no immediate control: the student's home and his preparatory school.

Unfortunately, the average student comes to the Institute, as he does to other colleges, from a home that is more interested in "Mutt and Jeff" and the "movies" than in books and good conversation; and from a preparatory school that has neither money nor personnel to do more than to prepare him, more or less parrot-wise, to pass the entrance tests. Those tests, obviously, can provide no more than the crudest rule-of-thumb measurements of a youth's real competence.

Therefore the average secondary school graduate arrives at the Institute not only ignorant of the technical subjects upon which his career as an engineer, chemist or architect must be based, but also with little background, and with even less preparation in those things which lead to genuine professional success. Moreover, from that entering day, which may well be regarded as his introduction to real life, he will be engaged in the disheartening process of exchanging the gold of inexperienced youth for a miscellaneous accumulation of life-experience, much of which is either junk or "bunk."

The main business of the college, therefore, is to help the youth, as an undergraduate and in the years thereafter, to get his money's worth in this life-long process of exchange. The undergraduate, awed by the vast array of apparatus at the Institute, will naturally conclude that his professional life will be passed among similar or even more splendid paraphernalia, and, if not warned against it, will acquire that habit of skilled manipulation which has kept so many technological graduates all their lives subordinate. One of the main duties of the Institute is to make its students understand that laboratory manipulation is merely a stepping-stone, and that the chief concern of an engineer is with men and ideas, not with machines and formulæ.

The bachelor of science on leaving the Institute should take with him a sound knowledge of the fundamentals of all engineering; a competent grasp of the broad principles — not the ephemeral technique — of his special field; a command of scientific reasoning that will enable him to build up from ascertained facts a solid conclusion; judgment, which will assist him to separate the true from the false, the essential from the non-essential; discrimination, so that he may choose wisely his "bosses," his subordinates and his friends; ability to get on with those three groups and to enlist their loyalty to him and to what he undertakes; self-respect, which will lead him to push himself forward faster than others will be interested or inclined to do; and self-control, which is, of course, the indispensable balance-wheel of any effective career.

As a foundation for these really essential things which the bachelor of science should possess, the so-called English subjects have an importance far beyond what most undergraduates and many teachers realize. No man can exercise judgment, either scientific or general, unless he can think clearly and succinctly; and there is no greater aid to such thinking than good writing, ready speaking and logical debating. No man can rise far in his profession unless he can be an equal among equals; and in the upper reaches to which all Tech men should aspire, men know history, economics, politics, books, art and all the other intellectually substantial things, and discuss them as a matter of course.

In these days of the typewriter, penmanship may not greatly count; but the ability to write a "gentleman's" letter, to talk so that real men will be glad to listen, to present one's case convincingly to one man or a hundred men, to do and say the right thing at the right moment are powers which count far above their literally intrinsic worth; for they are the things which determine, often preponderantly, almost every successful man's success.

These broad fields of interest which we have labeled "English" cannot be fenced off, however, by themselves. Every exercise in every branch of Institute study should be one in clear thinking, precise expression and effective presentation. Every recitation should be a training in talking "on one's feet." No technical subject but has its history, its economics and, indeed, its politics, all of which should be given due place and emphasis. And in class and out of class, students should be not merely encouraged, but urged, to mix, to organize, to manage, to debate, to coöperate — to get ready, in short, for what will be their chief business as engineers and executives: the handling of men.

In addition to this general practice given in all the classes and in every class, the Technology undergraduate should have specific training, even beyond what he already gets, in writing, in speaking, in debating, in historical perspective, in literary discrimination, and in those problems of economics which will confront him daily in the professional and business world.

He will be slow to believe his English teachers when they stress the value of these "useless" topics. If, however, the other members of the Faculty not only advocate them, but emphasize the importance of English, history and economics in their own technical fields,

the student will begin to "sit up." Furthermore, if the successful alumni and the practical "big" men of the business and professional world take pains to say publicly, as most of them do privately, that those intangibles are of more value in a successful career than all the purely technical subjects added together, the undergraduates will take hold with zest and eagerness of studies that too many of them now sadly neglect, only to realize, ten years later, their then irreparable loss. Since drives have become the fashion, let us organize one to be conducted by prominent men within and without the alumni, and to be aimed towards waking up the undergraduates to the vital professional importance of a knowledge of politics, economics, social relations and good books, of the ability to write convincingly, and of the power to talk easily concerning a wide range of topics, and to the unique training in clear thinking, sound judgment and discrimination which these too often despised "culture" studies give.

(*Signed*) JAMES P. MONROE.

MARKETING THE COLLEGE GRADUATE

The problem confronting the Senior at present is not so much, in most cases, a question of whether or not he will graduate as it is of what he will do when he has completed his education. Colleges have through their alumni and their undergraduate activities succeeded in inducing men to come to their institutions for education, and have given them, by the time they are ready to graduate, a sufficient training to take their place in the business world, but that is as far as they have gone. They thus produce a product for which they have no definite market. It is true that there is now a demand for college men but the time is coming when the supply will exceed the demand if some means is not used to increase it.

Business, in former years, took this same attitude of marketing its product only where there was a demand and did not create a demand, but it is now recognized that one of the most important phases of business is the marketing of products after they are produced. This is due in great part to the increase in competition and as the number of college graduates increases the same condition will probably prevail among them, for although there may be openings for all college graduates, it is difficult for the man in college to get in touch with these openings, and if there is a shortage of positions it is practically impossible for the college man unaided to sell himself to a job which never before has used a college graduate.

It is here especially that the college can help. It can keep in touch with the business world through its business relations and through its alumni, and can if organized to take advantage of these facilities secure and create through advertising and salesmanship openings which otherwise would not be found.

A SCIENTIFIC LEAGUE

A new home is being erected in Washington jointly for the National Academy of Sciences and the National Research Council which is intended to be a kind of scientific capital or distributing and popularizing agent for science in this country. Little by little we seem to be breaking away from the gross individualism and secrecy of the early days of science toward greater unity and coöperation among its exponents.

This is not the only case of its kind; in fact, our own "Technology Plan" of coöperation with industry, the Mellon Institute Fellowships, covering a surprisingly large and varied field, and the host of associations of scientists are all steps in the same direction. All these systems show the same signs — centralization, coöperation, unity, but nearly all deal with different subjects, there being only one of which we know much, that makes an effort to link all the sciences — the American Association for the Advancement of Science and this is loose in its construction.

Hardly a day passes that some one does not find fresh evidence of the unity of the sciences and scientific men are becoming more and more convinced that each science has something to offer to the others but they are slow to strengthen the organizations that already exist for the exchange of information. There is everything to gain and nothing to lose by developing an efficient and far-reaching system of exchange.

What is needed is a national, or better, an international union for learning, applied science, and the arts which will also be in direct contact with the co perative systems between research and industry and have a new contact, as yet undeveloped between the secondary and the higher educational systems.

Such a union, actually working, would have many and far-reaching results: the elimination of duplication of effort all around, more rapid approach to conclusions in research, immediate application of new-found principles to industry, keeping educational schemes up-to-date, as well as eliminating friction between the secondary and the higher systems.

Beginning with this national scientific capital idea as a nucleus, the existing associations for the various subjects should be drawn together into a kind of scientific league.

THE RUBBER CLASH

Great indignation seems to have been aroused amongst the many manufacturers of automobile tires and other rubber goods, in this country, regarding the Stevenson Plan to limit the output of crude rubber in the British Dominions. This plan, by a schedule of export taxes varying with the prevailing market price, restricts the output of rubber in the British Empire to sixty per cent of the 1920 crop, until the price overrules thirty cents per pound, thence the plan provides for successive adjustments, permitting one hundred per cent production, when the price of seventy-five cents per pound is attained.

For some time the price of raw rubber has been so low that the planters have not been turning over any profit at all for their labors, and consequently, to save them from bankruptcy, the above plan was originated, thus regulating the export of the material until the price automatically adjusted itself. This, however, did not seem to meet with the approval of the large American manufacturers. In one case, it was reported that retaliation might be resorted to, by limiting the export of cotton. Yet, would we be surprised to hear that the above ruling, with regard to rubber, was in retaliation for the high price of another and much more universal commodity, namely sugar? No such thing was thought of, but it might very well be. No one seems to grumble at having to pay what is really an exorbitant price for sugar, perhaps the most necessary substance for the sustenance of human life in the world. This high price is due only to lack of proper supervision of and in allowing excessive speculation in the American sugar market. At the present time the United States enjoys a monopoly of this material, and exports the refined article to almost every corner of the globe. Sugar is more necessary than rubber; then why should not the output of sugar and its price be stabilized before that of rubber? The rubber manufacturers resort to the plea that the automobile owner is complaining at the price he has to pay for his tires, but nothing is said of the confectioners, of the housekeepers, of the large contracting caterers who daily repine at and complain of the excessive price they have to pay for their sugar supplies.

RESEARCH AT THE INSTITUTE

(*Continued from page 47*)

quantitative study by exact physico-chemical methods of the effect of environment on the rate of reactivity of atoms, a subject of great theoretical importance, and second, a study of the chemistry of the simpler compounds derived from petroleum. In connection with the latter problem, cracking and refining processes are being studied with a view to the utilization of their products as raw materials in industry.

The Department of Metallography too has attracted a number of graduate students who have desired to work under Professor Fay. The most recent problems investigated relate to the effect of nitrogen in steel.

The same year, 1903, that the Research Laboratory of Physical Chemistry was inaugurated, a laboratory known as the Sanitary Research and Sewage Experiment Station was established in the Department of Biology. The work of this laboratory was directed by Prof. William T. Sedgwick, and included investigations on water purification, sewage disposal, disinfectants, ventilation, and food control. Ten volumes of reports testify to its activity. Investigations were continued until 1918 when the death of the donor, whose generous contributions had financed the work, brought the activities of the laboratory to a close. Biological research has also been carried on in the Institute laboratories for many years. Among the problems now engaging the attention of the staff the following are of particular interest:

Professor Prescott's research, which has extended over several years and is the most comprehensive of the kind that has ever been made, on the chemical and physiological action of coffee; an investigation carried out for the Bureau of Fisheries, on the reddening of codfish, with some collateral problems pertaining to the fish industry; and problems related to nutrition and a study of the chemical changes produced in foods when subjected to various baking processes as carried out on a large scale. In the field of bacteriology and industrial micro-biology investigations have been resumed which were interrupted by the war.

The next department to establish a research laboratory was that of Electrical Engineering. Professor Jackson had long emphasized the great importance of fostering research among the members of his staff, and in 1913 established a "Research Division" under the direction of Prof. Harold Pender. This was further developed in 1915 through a coöperative arrangement with the American Telephone and Telegraph Co., the company making annual appropriations for carrying on research. Since the "Tech Plan" was put into operation in 1919, the Research Division has been financed from appropriations from the general endowment fund. The work is administered by a committee of the Department of which Prof. A. E. Kennelly is chairman, and this committee has general oversight of all research work including that of graduate students. A staff of research assistants, many of whom are working for higher degrees, carry on investigations under the direction of the members of the committee. A number of very important papers, thirty in all, have already been published from this Division. To enumerate all of the interesting investigations now in progress in this laboratory is quite beyond the scope of this article; but the following researches will give an idea of the diversified program now under way:

HYDROGEN ELECTRODE APPARATUS

(*a*) An investigation of transient phenomena and their bearing upon the problem of interconnection of great power net works by some such scheme as that outlined in the Superpower Survey. For the investigation of problems of this kind the laboratory has developed a special artifical transmission line.

(*b*) The distribution of harmonics in transformer banks, a problem proposed by Dr. H. S. Osborne of the American Telephone and Telegraph Co. This complicated problem has to do with the interference on telephone lines induced by harmonics, passing into connected transmission lines from the transformers.

(*c*) A research on paper insulated cables undertaken at the request of the National Electric Light Association.

(*d*) The properties of glass and other insulators suitable for high voltages — a problem recommended by the National Research Council; also problems on corona discharge, skin effect of large conductors at low frequencies, radiation resistance in connection with radio-antennæ, power transmission over cables, and refinements in generator and motor design.

The most recent research laboratory to be established, 1919, is that of industrial physics under the direction of Prof. C. L. Norton. The purpose of this laboratory is to provide facilities for handling the increasing number of problems which have been referred to the Department of Physics under the Technology Plan. The work is carried on by a staff of research assistants. Most of the problems now being investigated are of a confidential character but one relating to the caustic embrittlement of steel may be mentioned.

Research in pure physics and electrochemistry is in progress in the various laboratories which collectively constitute the Rogers Laboratory of Physics. Perhaps the most novel work is that on photo-elasticity under the direction of Dr. P. Heymans, a recognized authority on this recent very important application of polarized light to the study of stresses and strains in structures which are too complicated for mathematical analysis. At present certain problems presented by the United States Navy are being investigated. A special laboratory has been equipped for this work.

In the heat laboratory the following researches should be mentioned; the variation of thermal conductivity with the temperature; the physical structure of refractories and their specific heats at high temperatures; and heat losses from metallic surfaces in high velocity air currents.

In the optical laboratory researches on the thalofide cell and on its use in pyrometry, on a new photometer for measuring optical densities, and on the sensitivity of photographic emulsions are under way. Other investigations in physics have to do with X-ray spectra, Reststrahlen, resistance thermometry in the region of absolute zero,

(*Continued on page 60*)

Cake Eater
—*model of 1900*

He was called dude and dandy then, but you recognize the type.

He majored in haberdashery and took his degree with honors in soxology.

As if that were not enough, he evolved some variations on the cake walk which made them stare.

He even found time to develop a remarkable proficiency on the tandem bicycle, and on Saturday nights he was good enough to bring pleasure into Another's life by wheeling away to the "Ten-Twent-Thirt."

To crowd all this into four short years would seem enough for any mortal. Yet in spite of his attainments there are times, in after life, when our hero wonders.

The glory of his waistcoats has long since faded, while his books are still fresh and clean. Did he perchance put too much thought into the selection of his hats and too little in what went under them?

Published in the interest of Electrical Development by an Institution that will be helped by whatever helps the Industry.

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Number 28 of a series

RESEARCH AT THE INSTITUTE

(*Continued from page 58*)

and an acoustic research on the persistance of resonance.

In the electrochemical laboratories current investigations relate to overvoltage and electrolytic reductions, corrosion, electrolytic depositions and the effect of ultra-violet light and high frequency discharges on photochemical reactions. Here also an extensive research extending over several years on the Quartz Mercury Arc is in progress, as well as an investigation on the absorption of its radiations by thin metallic films.

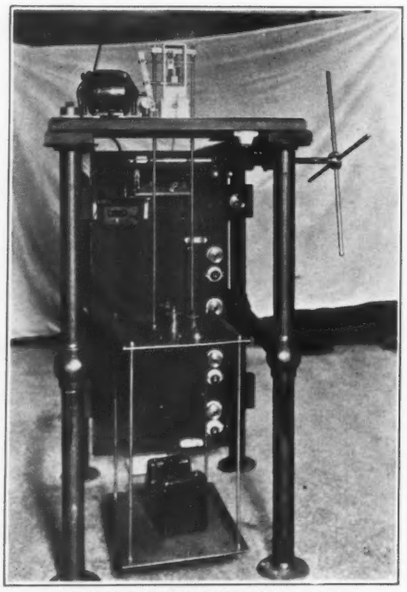
The work in aeronautics, assigned to the Department of Physics, is in charge of Prof. E. P. Warner who directs all research carried on in the seven and one half foot wind tunnel. This is subsidized by the United States Army which has had models of all recent airplanes tested here. In addition to such tests, much original work on the stability, balance and controllability of airplanes is being done, and it is interesting to know that predictions based on tunnel tests have almost invariably been confirmed by the reports of the army test pilots on new airplanes.

Another department which has made a most enviable record for itself in the matter of research is that of the geological section of the Department of Mining, Engineering-Metallurgy and Geology. For the size of its staff it has probably published more than any other department of the Institute. This work has attracted graduate students not only from this country but from Canada who desired to specialize in economic geology, paleontology and petrography.

The Department of Mathematics, too, is at present very actively engaged in research. In fact, a student desiring to pursue advanced work in mathematics will go far to find a more attractive list of courses than is at present offered by the staff. The total number of original contributions published during the past three years was fifty-two. It was to encourage research particularly in this department, that the Executive Committee in 1921 appropriated funds to publish the *Journal of Mathematics and Physics*. So few journals are available for the publication of research in mathematics that frequently an author must wait a year or more before he can get his work into print. The new journal is under the immediate charge of Prof. C. L. E. Moore. Six numbers have already appeared and are a credit to the contributors and to the Institute.

Although the Departments of Civil and Mechanical Engineering have not established separate research divisions, nevertheless, research problems are constantly finding their solution in their laboratories. Thus in the Department of Civil Engineering the following investigations are now in progress:

In hydraulics, an experimental study of a model loaned by the New England Power Co. of a circular spillway; the determination of the contour of water flowing over a masonry dam across the Merrimack River; and the effect of wind upon the level of the Great Lakes. In structural work, the principal researches are an experimental



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Two thousand atmospheres.

verification of a new theory of the deflection of arch ribs, developed by Professor Spofford, and an investigation of a mechanical method for the solution of statically indeterminate structures.

In mechanical engineering, three investigations deserve mention; the first, an investigation on the Cannon radiating furnace in which carborundum which has a high conductivity is used as refractory material. The purpose of the research is to determine the total fuel which can be burned per hour per cubic foot of combustion space; it is believed to be very high. The other two pieces of work are on the effect of divorce annealing on the physical properties of steel and a study of annealing malleable iron respectively.

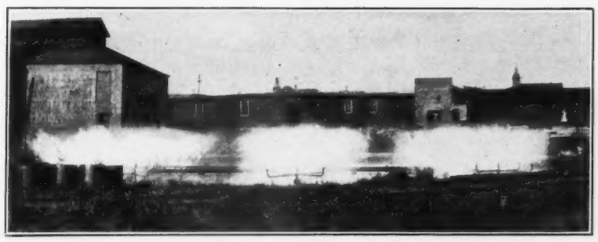
From the above resumé of the research activities throughout the Institute, it is clear that nearly every department is at present committed to a program of research, which if continued and further developed is bound to add greatly to its prestige.

To encourage the younger members of the staff to undertake research, President Maclaurin in 1919 established a fund for the purpose of relieving those who had demonstrated their ability to carry on independent research, of a portion of their teaching duties, in order that they might have more time to devote to their investigations. This policy has been most gratifying in its results. To cite only one instance, members of the Department of Mathematics who have benefited under grants from this fund have been able to increase the number of their publications from eighteen to forty-four, during the past two years.

It is also encouraging to know that the importance of providing for research in science at the Institute is beginning to be recognized outside. This has been shown in a most substantial way by several prominent alumni who stipulated that their contributions to the Endowment Fund should be devoted to the development of research. Additional gifts of this kind are greatly needed, not only for research but also for graduate scholarships.

The "Tech Plan" as carried out through the Division of Industrial Coöperation and Research now brings the Institute and the industries into such close relations that ample provision in the future seems assured for research in the field of applied science. There is danger, however, that research in pure science which is the very corner-stone upon which all progress in applied science rests, may become over-shadowed by industrial research and relegated to a subordinate place. Equal provision should be made for the maintenance of both, and fortunately under President Stratton we may look forward with confidence to seeing this done, for it was this policy which made his administration of the Bureau of Standards so notable an achievement.

Gas production by electricity. Unique in the field of utilizing all its waste products, and making practically all of its own materials of manufacture, the United States Light and Heat Company at Niagara Falls is now generating all the gas used in its entire plant by the electrolysis of water at their own plant. A special building and equipment is used for this purpose. Fifty generators are used and an enormous amount of gas is produced.



The Above Illustration Shows the

Spraco Cooling System

In connection with the Municipal Power Plant of the City of Dothan, Alabama, capacity 3,000 gallons per minute. Note the uniform spray, even distribution and clear air passages. The Superintendent reports that when carrying full load in the hottest days of summer they never obtain less than 27 inches vacuum. In November last they were running with 29.6 inches vacuum. They changed from the old spray system to the new "SPRACO" inside of forty-eight hours.

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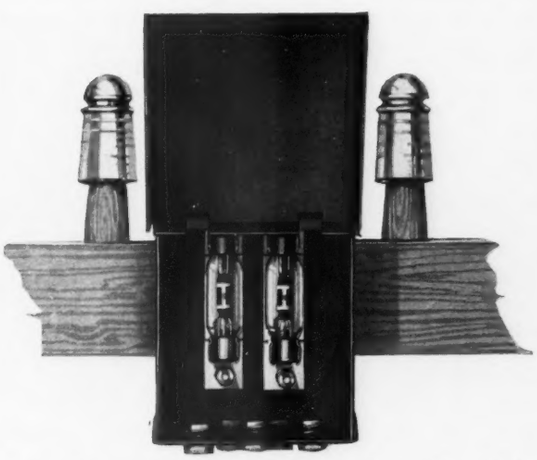

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IN
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for the protection of low voltage circuits because with them they can have uninterrupted service; intact equipment; positive protection against static; lightning; crosses; and grounds.

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TANDEM GEARED ELEVATORS
For Heavy Duty

For heavy duty, Haughton Tandem Geared Elevators have established an exceptional record of continuous service with extreme economy.

More than 800 Haughton Tandem Geared Elevators have been installed in the past 17 years. To our knowledge, no gears have ever been replaced on account of wear.

Some of the engines have been operated for years on 24-hour service, working three operator shifts of 8 hours each.

A list of recent installations, giving plants using Haughton Elevators, will be sent on request to Department T.

Kelly-Springfield Plant at Cumberland, Maryland
Complete equipment of 11 Haughton Tandem Geared Elevators

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New York
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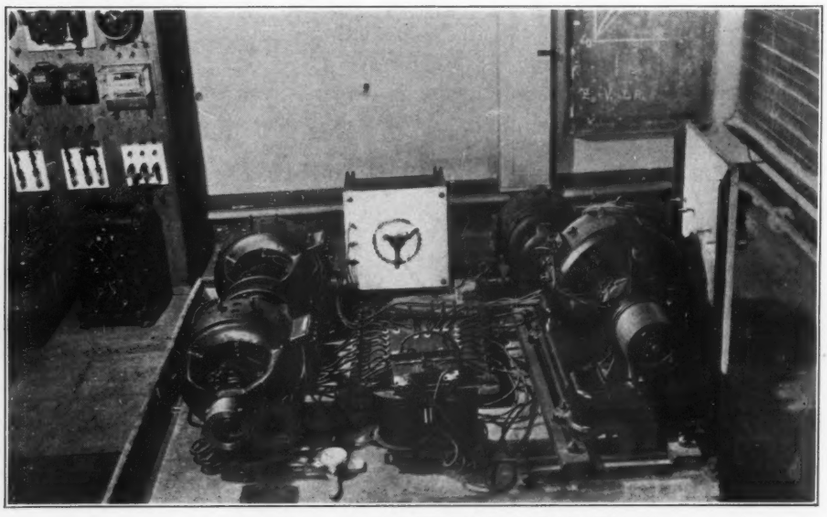
Cleveland
Detroit
Akron
St. Louis
Youngstown
Lima
Oklahoma City

ENGINEERING EDUCATION IN FRANCE

(*Continued from page 45*)

candidates is extremely desirable. In some cases only one out of six candidates is admitted. This assures the intelligence of the entering class, though the examinations as given do not test the special aptitude of the men for engineering work any more than ours.

In October, after an enjoyable summer, the writer left the University of Besancon, and returned to Paris where all of the "great engineering schools" are located. During the remainder of the year, he had occasion to visit them and investigate the work.



A PART OF THE ELECTRICAL LABORATORY
One of six similar platforms used in the Laboratory, showing the arrangement of the machines and wiring.

The oldest is the Ecole Polytechnique founded by the Convention in 1793 as an engineering school. At that time there were two branches, military and civil engineering; but due to the number of wars in which France engaged in the succeeding years, the school took on the decidedly military aspect that it presents today. The course is of two years' duration, after which the graduate may enter one of the military services, become an engineer in a state-controlled monopoly plant, such as tobacco and match manufactories, or continue his education in one of the special schools, such as the Ecole des Mines, the Ecole des Ponts et Chausées or the Ecole Supérieure des Postes et Télégraphes, all of which are under government control. The higher officials in the technical services of the government are graduates of these schools.

The school which the author visited as Exchange Instructor, the Ecole Centrale des Arts et Manufactures, was founded in 1829 by private initiative and remained up to 1865 a private enterprise. At that time the state assumed a certain degree of control, though its fiscal autonomy was guaranteed, and the state's supervision largely nominal.

In its early years like most similar institutions, it passed through many difficult periods and for a time after the government took over the direction, it languished, but the active aid of its alumni has enabled it to weather all storms. From the eminent position it now occupies, it may be said to have the same relation to industry, that the Ecole Polytechnique has to the government administrators.

Its admission requirements are nearly on a par with those of the Ecole Polytechnique, consequently the men who enter are of high mental caliber. Differential and integral calculus with simple differential equations are required for entrance. The requirements in physics and chemistry are almost equally advanced.

Thus the school accomplishes in large measure in its three-year course what we take four or even five to achieve. The curriculum is encyclopædic in content, and though a specialization exists in name, in reality there is very little difference between the work of men in different courses. The laboratory work only is specialized. There are four courses; civil, mechanical, metallurgical and chemical engineering. The lectures are the same for all students.

For the most part oral instead of written examinations are given. An examining board of two or three professors or instructors sit in a special room and while one student is at the blackboard answering the examiners' questions two other students work in the same room on the questions, preparing the solutions, which each in turn places on the blackboard. Each man is then interrogated about ten minutes. Classroom recitation, as we know it, does not exist to any considerable extent at the Ecole Centrale.

The laboratory instruction is carried on in large groups in the heat and hydraulic laboratories, while in chemistry each man has his assigned desk and closet space.

The writer worked in the Laboratory of Industrial Electricity. Here he found his ability to handle the language improved by daily contact with students. He was always shown the greatest deference and consideration, in spite of his being the only teacher of a foreign nationality in the school.

The electrical engineering laboratories of the Ecole Centrale are well arranged for handling large numbers of students with a minimum of supervision and investment in apparatus. Curiously enough their Dynamo Laboratory is much more standardized than any like laboratory in America within the writer's knowledge. This is perhaps due to the fact that the director of the laboratory is very competent, having besides his educational duties a large industrial consulting practice. He has devised a series of experiments suited to his standardized apparatus so that all the fundamentals of dynamo machinery are covered in some ten tests. He also has arranged a definite postgraduate programme for men who decide to enter electrical industries after graduation.

The Ecole Centrale is located on the north bank of the Seine River outside of the Latin quarter where most of the schools have grown up. Its five story brick building occupies a small city block. Like most continental schools, it is built around a large courtyard, where the first year men undergo the required military drill. This courtyard also provides the students with space for recreation periods.

Discipline there is very exacting. The gates are closed at eight-thirty a.m., and all students are expected to remain in until twelve. They re-enter at two and leave after five p.m. If a student has no lectures or laboratory classes he is required to stay in the study room where he has his assigned desk and does his drawing or studying. To be permitted to leave the school during hours, the student must have an order signed by the "inspector"

(*Continued on page 64*)

MEASURING UP TO A FAMOUS NAME

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To the Wright nineteen-year-old experience in correct aeronautical engineering practice is added the production facilities and organization that bespeak the Quality of the Wright product.

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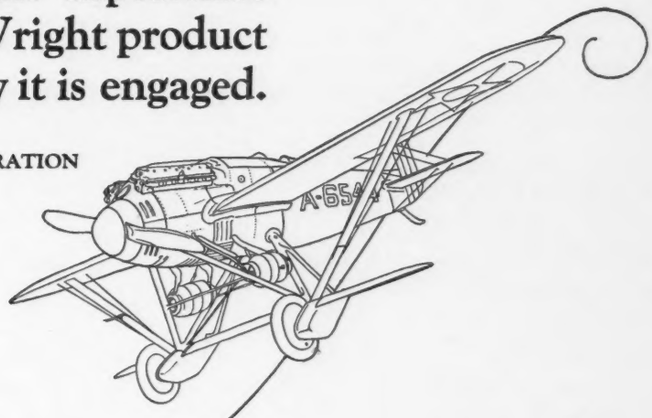


"The Identification of Incomparable Service"

WRIGHT

ENGINEERING EDUCATION IN FRANCE

(*Continued from page 62*)

assigned to his section whose duty it is to check up attendance and deal with matters of discipline. This may seem a bit childish to the American student, but the French are accustomed to it throughout their school life.

Socially the students of the Ecole Centrale are not so much given to group activities as are Americans. There is, for example, but one official school dance during the year. They spend their leisure hours individually or in small groups.

To a Tech man the most interesting of their student activities is the annual "revue" which corresponds rather closely to the Tech Show. It is written, produced and staged by the students. Incidents of life at the school, take-offs of various professors, with catchy songs make it a charming musical comedy.

Most of the professors represented in the show were present at the 1921 performance in the Apollo Theatre and thoroughly enjoyed the jokes at their expense. The audience was made up of enthusiastic students and alumni.

The answer to the question, "Can we learn anything from the French schools?" is certainly "Yes — much." The author believes that with certain modifications made necessary by the differences in the characteristics of the races, many features of the instruction at the Ecole Centrale could be profitably adopted at Massachusetts Institute of Technology.

The Ecole Centrale is at present exclusively an undergraduate school, so that there would be no occasion for any American graduate student desiring to spend a year of study in France to spend it there. Such a man would find ample opportunity for advanced work either in one of the special schools in Paris, or at one of the technical institutes attached to the provincial universities.

In conclusion, the writer wishes to emphasize the importance of the exchange of students as well as teachers, as a means of promoting the rapprochement of France and the United States. In addition to the technical instruction and training in the incomparable scientific logic of the French, students would have the opportunity of gaining that broader outlook on world affairs which we so urgently need in this country now, and shall require in ever-increasing measure as time goes on.

FLYWHEEL EXPLOSIONS AND THEIR PREVENTION

(*Continued from page 51*)

side of indicating the wheel less safe than it actually is. This assumption is to the effect that the flywheel is a ring revolving in space. In other words, it assumes that the spokes do not tend to hold the wheel together. While there are undoubtedly wheels which are partially held in place by the spokes, there have been enough cases proven of actual compression against the spokes to justify those who calculate wheels in considering that the spokes at least do not help to hold the rim together.

If the engineer could watch the erection of the flywheel and make a record of the conditions existing as the flywheel goes into place, much that is later questioned could be answered. I have in mind a corporation in Chicago which erected a power house and put in a number of reciprocating engines. Link jointed flywheels were used since the engines were direct connected to generators and since belts and ropes were unnecessary. When the last link was cooling down, after it had been shrunk in place, it broke. This made the company which had bought the wheels suspicious and they drilled a small hole in each of the other links. Although the link was several inches wide and the hole was probably only one-fourth inch in diameter, the removal of this small amount of material was of sufficient importance to cause several other links to break. The reason for the breakage was that the links had been made too short in the first place. Consequently, it had been necessary to heat them very hot and as they cooled to the room temperature the stress put in them was too great. It exceeded the strength of the link in only one case, but had the other wheels been run up to speed it is quite possible that all of them would have broken. Had the erecting engineer carefully measured the link itself and the place where it was to be fitted, he would have been able to have determined the stress and to see that it was too high after the link had cooled. On the other hand, had the company's engineer noted the high temperature to which the links had been heated, he would have known that there was something wrong in the design. Any company which has important wheels to set up should assure itself that matters of this kind are not overlooked, since it is practically impossible to determine conditions after erection without tearing the wheel down.

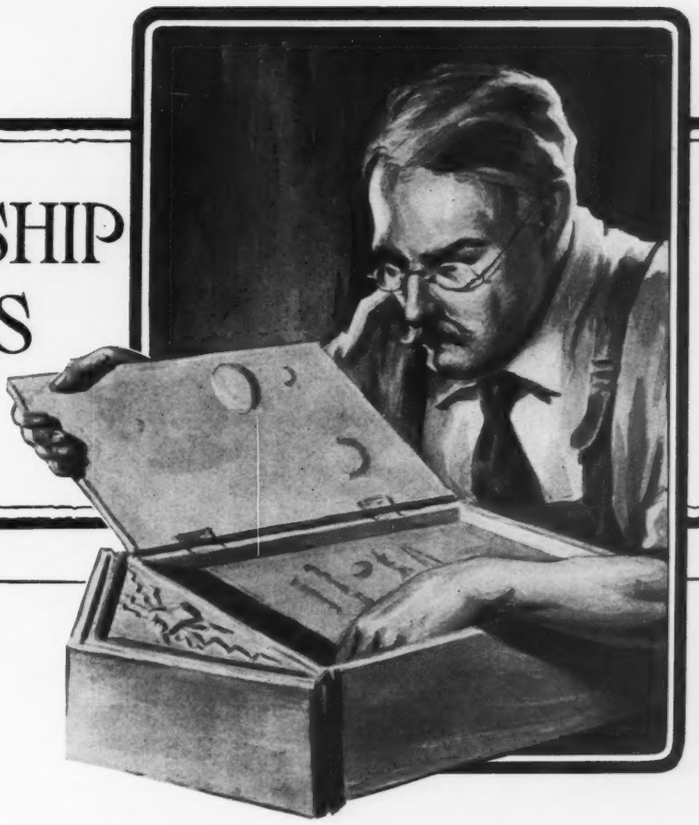
While the principal cause of flywheel accidents comes from overspeeding, which may be normal or momentary, there are many contributing causes and several independent ones. The principal divisions are overspeeding, overloading, and failures due mainly to defects, flaws, and improper handling. The causes of overspeeding usually are breaking of engine parts, breaking of engine belt, breaking of governing arrangement due to numerous causes such as breaking of governor belt and derangement of governor, or loss of load. Overloading may be caused by clogging of machinery in mill, unusual number of machines forced at same time, careless or ignorant handling of friction clutches, or short circuit of driven electrical machinery. Of all causes of flywheel accidents derangement of the governor is probably the principal one and broken belts the next most important. Anything which will eliminate any of these causes will lessen flywheel accidents.

The table below, which is made up for ten foot cast-iron wheels, shows the relative balancing effect of wheels at various speeds and the factors of safety of two types of wheels, the increase of speed necessary to break the wheel, and relative elapsed times necessary to reach breaking speed. It should be understood that the balancing effort and the times necessary to reach breaking speed are relative figures only.

TEN-FOOT DIAMETER CAST IRON WHEELS

	Flange Jointed Wheel				Solid Wheel		
Revolutions per minute	*Balance Effect*	*Factor of Safety*	*Increase of speed necessary to break*	*Time to reach breaking speed*	*Factor of Safety*	*Increase of speed necessary to break*	*Time to reach breaking speed*
96.87	1	10.00	2.16	1	40.00	5.32	4.33
150.00	2.41	4.16	1.04	0.84	16.62	3.08	4.18
193.74	4.00	2.50	0.58	0.67	10.00	2.16	4.00
306.00	10.01	1.00	0.00	0.00	4.00	1.00	3.33
612.00	40.00	....	....	....	1.00	0.00	0.00

CRAFTSMANSHIP THAT SAVES LIVES



FINE WORKMANSHIP may add to the pleasure you get from an article—as in a fine picture. It may add to the service you get—as in a fine tool or it may add to the protection of of your life—as in fire alarm apparatus. In the first case fine workmanship is desirable. In the second it is valuable. In the last it is absolutely essential.

Two things have contributed to make noticeable the standard of our workmanship. The first was the necessities of the case — the protection of life. The second was the type of our workmen. Scores of these men have been with us twenty years. All of them have a pride in doing their job as well as they can—not as cheaply as they can. They know that the lives of the children in the schools—the sick in the hospitals—the infirm in the homes—and the workers in the factory — depend on the apparatus which they build. They build as well as they know how—and when life is at stake no other standard is possible.

The Gamewell Fire Alarm Telegraph Co.

Newton Upper Falls, Mass.

DUST COLLECTING AND PNEUMATIC CONVEYING

(*Continued from page 52*)

a small air motor, centrally located on each compartment, violently shakes the head frame to which the twelve sieves are fastened. When the outlet is closed outside air rushes in.

This clean air, pulled in by the vacuum maintained in the operating compartments, follows a reverse course, and passes from the outside to the inside of the bags. This air current, with the shaking, loosens the dust and carries it to the hopper at the bottom of the compartment where the dust is sacked or automatically discharged into a conveyor.

Shaking or cleaning the bags lasts but a few seconds. While one compartment is cut out for cleaning the other compartment is doing the filtering.

The consumption of compressed air for cleaning is about one half to one cubic foot per minute per compartment, at about thirty-five pounds pressure, according to how frequent the compartments have to be cleaned.

Closely related to the question of dust recovery is the question of pneumatic conveying. There are two systems in use — the pressure system and the suction system. We naturally find minor variations of each system. The pressure system conveniently divides itself into low and high pressure work. A low pressure installation is used for conveying waste material from woodworking plants, rags, and similar light stuff.

The quantities of air handled are relatively large and therefore the pipes are generally large sheet iron pipes. The velocities used are from a few hundred to five or six thousand feet per minute.

In high pressure work only a small quantity of air is required and therefore the pipe lines can be made much smaller. Because of this, the pipes can be made more substantial and can be run in more inaccessible places. High pressure pumps of rotary type are generally used. The velocities which may be obtained vary from three to twenty thousand feet per minute. In both the high and low pressure system after the greater part of the material has been dropped in a storage tank or separator the air is blown through a filter to take out the very finest dust. As an additional precaution these filters are generally put under suction from a second pump.

The simplest form of suction system consists essentially of a pipe line to a receiver. From the receiver the pipe leads to a vacuum pump which draws the necessary air at high velocity through the conveyor pipe and receiver with force sufficient to carry the material.

The material is trapped in the receiver, its velocity diminishing in proportion to the relative cross sections of air line and the receiving chamber. Gravity carries it to the hopper-shaped bottom of the receiver, where it is discharged through an unloading lock. The air, after being relieved of the material, is drawn through the pump and discharged.

This equipment is highly satisfactory for a variety of purposes, but it is plain that it cannot be used for materials carrying a light and fine dust because a metal receiver is not calculated to remove all such fine ingredients. They would be drawn through the pump and discharged with the air, incurring three drawbacks, any one of which might condemn the apparatus for the material in question. (*a*) The discharged particles may be too valuable to waste. (*b*) They may be offensive in the surrounding air. (*c*) If abrasive in their nature they will quickly impair, and eventually ruin the air pump through which they are drawn.

Warning must still be given against the use of either of these simple and therefore, inexpensive forms of equipment for any material where there is a large percentage of fine dust, or where any dust, however small in quantity, is of an abrasive character.

From what has been said previously, it is obvious that the improved filter described would be better than this equipment. Also by a proper combination of receiver and filter, the coarse and fine particles can either be collected in one receptacle or separately as desired (see Fig. 2).

Installations have been made for unloading phosphate rock from vessels to dock, for removing arsenic from settling chambers, for removing lithophone from crushers, the lump varying from 1½ inches to very fine material, for conveying rice, grain, and for conveying carbon black. This latter is the finest and perhaps lightest material dealt with; lime, soda ash, gypsum, salt, coal, etc., etc., are only a few of the materials which today are handled successfully with this modernized equipment.

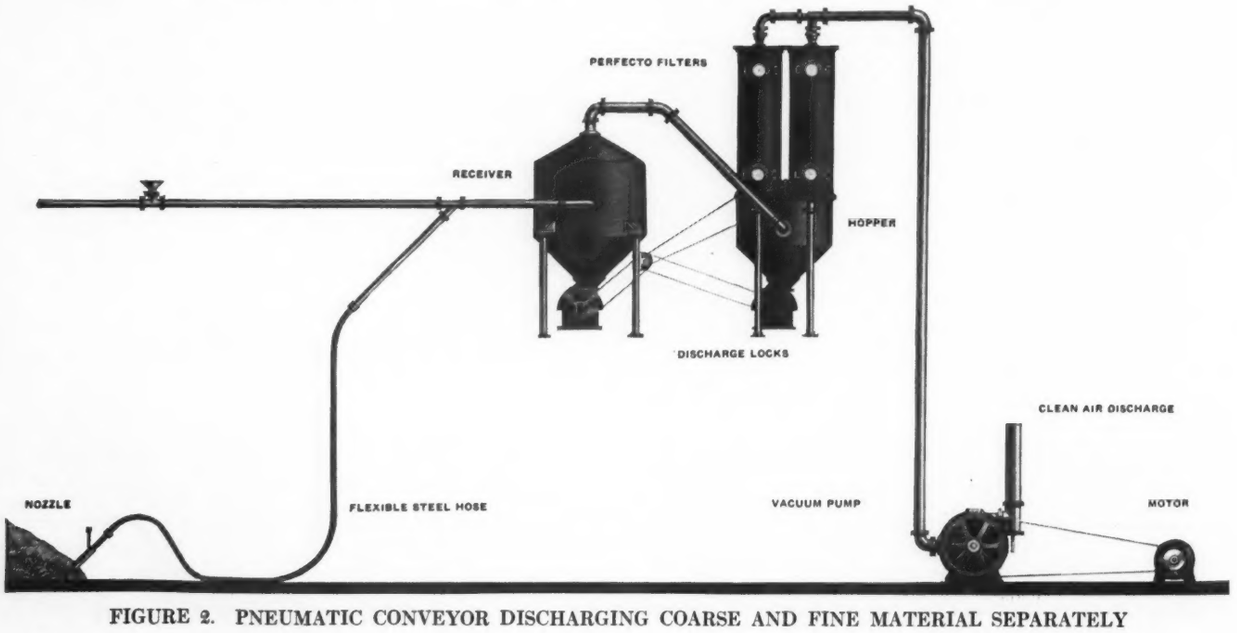


FIGURE 2. PNEUMATIC CONVEYOR DISCHARGING COARSE AND FINE MATERIAL SEPARATELY

The Birth of a Bottle

A HUGE TANK — feeding white-hot molten glass into a clever device that releases it in measured amounts at proper intervals to a battery of moulders. These moulders — ponderous machines — revolving and reversing, form many bottles at each operation with more than human skill. Deftly the glowing cylinders are unloaded and delivered to the annealing ovens. Here they are treated by a process that makes them exceedingly tough and able to stand the tests of service.

Now comes a close inspection by experts to eliminate the occasional bottle that may be less than perfect. Then on into the shipping room where careful packing insures safe transit in the waiting freight cars. Thus, briefly, are bottles born, yet how infinite has been the experience and inventive skill back of the process.

Foremost among American bottle manufacturers for generations, and outstanding in its contributions to the industry has been the SALEM GLASS WORKS. High standards of quality, perfect service and absolute integrity have always been the aims of this concern. Establishment of them has placed the Company in the high position it occupies today.

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SALEM, NEW JERSEY

Nothing is impossible when it comes to giving better service and making better goods

WILLIAM I. WYMAN

(*Continued from page 48*)

ness organization. There are stored for sale about fifty million copies of patents and trademarks on about twenty linear miles of shelving. The application files of all the patents granted and trademarks registered are kept accessible for public inspection. There are over one and one-half million individual files, each of which gives the history of the prosecution of the case to an issue, and is essential to an understanding of the grant. All this matter was stored on wooden shelves when Mr. Wyman took charge, but much of it is now about to be transferred to specially designed fireproof shelves rationally arranged.

The Patent Office includes an assignment division which is more active than many recorders of deeds' offices in large cities, and which contains the records of all transfers of property in all patents and inventions and trademarks throughout the entire United States. There is also a division which reproduces records for inventors, attorneys and the courts, including a large corps of typists and reproducing machinery for making photostats of records and books accessible only in the Patent Office.

A scientific library, which is also under the administration of the Chief Clerk, is one of the most important and most active special libraries of the United States; it contains a large amount of literature on the technical arts, and is the only place in the United States where can be found a complete assemblage of published patents granted and trademarks registered by foreign nations.

There is also a large division in this office which looks out for its printing and publications and the issuance of its patents. The Patent Office expends for printing and photolithography over $900,000 per annum, and in this respect this Bureau spends more money than other entire departments of the Government, and much more than all of the other bureaus of the Interior Department put together. The Government Printing Office, the largest printing office in the world, has ninety-seven linotype machines, of which fifty are used exclusively for the Patent Office work.

It is remarkable that the Patent Office, where the technical work is always forward looking, where many things are disclosed prior to their entry into life, and where improvements of all sorts, while not born, are christened, should have carried on its work for years with antiquated equipment. Mr. Wyman grasped the opportunity given him, and did much to make the office resemble a modern institution. Without doubt he has set a highwater mark among the chief clerks of the office. His ability to see the good in everything and to see a new aspect of everything has been invaluable to the Government, and particularly to those with whom he has come in contact.

The Patent Office offers an assured career of usefulness in public service to any young man technically educated, who possesses ability and energy. Service in this institution gives knowledge of its practice and procedure, and an opportunity to receive an education in law, which can be acquired outside of office hours in Washington. Such experience and education prepare one to assume the higher positions under the Civil Service with a salary as high as $5,000 a year, or to enter the patent law profession, which is a fairly lucrative one, and in which there are greater demands for the right material than there is supply. Many of the eminent figures at the patent bar have graduated from the staff of the Patent Office. The positions are filled from lists made from competitive Civil Service examinations held at various points throughout the country every few months.

In 1913, Mr. Wyman won the first prize in the *Scientific American's* international competition for an essay on the ten greatest inventions of the preceding quarter century. He has been a frequent contributor to the *Scientific American* and other publications on Patent Office history and inventions. He has contributed to the technical papers issued by the members of the Patent Office examining corps, and has been since September 1, 1921, editor-in-chief of the *Journal* of the Patent Office Society.

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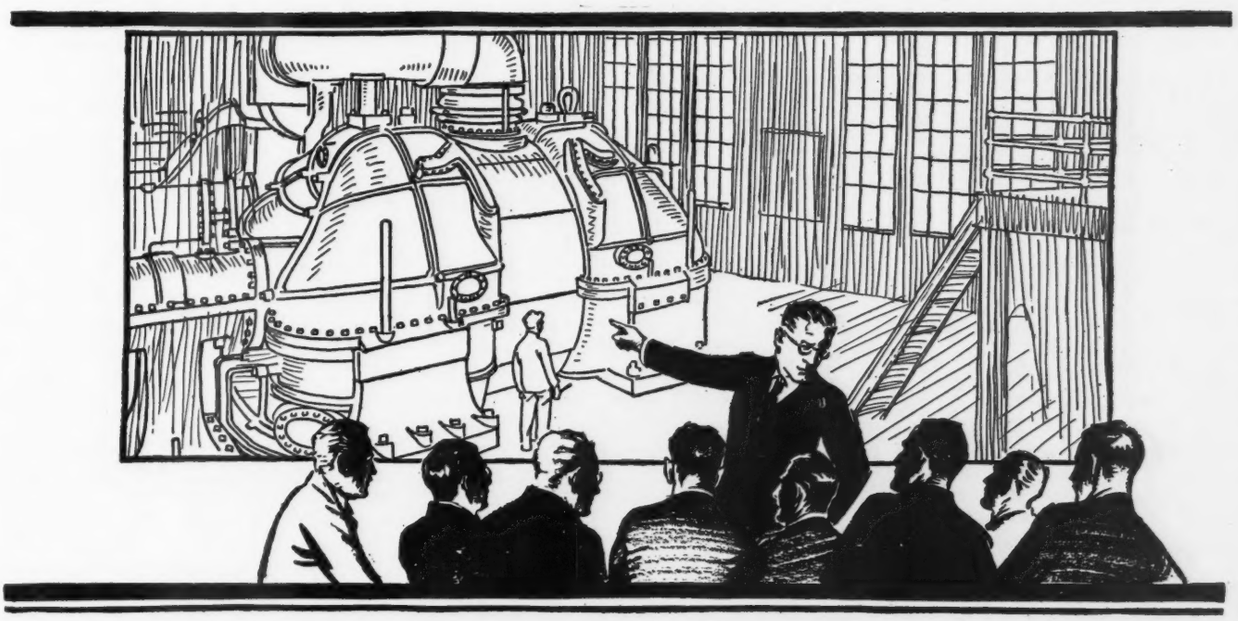
Massachusetts Institute of Technology
Cambridge, 39, Mass.



The University of Engineering

Of all the things that go to make the successful engineer, none is more important, nor more in step with the spirit of the profession, than a studious attitude. One man says about another—"he is always willing to learn," "he doesn't think he knows it all"—and he intends to pay a high compliment when he says it.

The great engineers are always at school, always learning, always seeking for more knowledge. They begin with this desire for fuller understanding, and they keep it up to the end.

Any engineering operation, over and above the primary purpose for which it is carried out, is an active and post-graduate class in engineering, also. So that Westinghouse, or any other great business, is, of its very nature, a University where theory and practice combine to make bigger, broader and more practical engineers.

The courses in this University are not limited to prescribed subjects nor terms—the subjects are almost infinite, and the semesters are endless. Men with the weight of years on their shoulders work and learn side-by-side with those whose day has just dawned.

This post-graduate school fits men for almost anything. Fits them for it, and makes them continually fitter. Out of this continuing fitness have grown the engineering accomplishments on which this institution has grown. It is, perhaps, one of the great educational institutions of its day.

Westinghouse

ACHIEVEMENT & OPPORTUNITY

W
WESTINGHOUSE ELECTRIC

DESIGN AND MANUFACTURE OF INSULATORS

(*Continued from page 49*)

a large percentage of these early insulators are still in service. It is believed that these problems have now been solved by the use of proper expansion joints at necessary points and by proper treatment of the cement during the time that it is setting.

Several thousand Hewlett insulators were also made at that time but they did not prove as popular as the cemented types for the latter as then produced could be made much more cheaply. After many years of operation, it is found that most all of the early Hewlett insulators were still in service so that the insulator is being made again to supply an insistent demand.

Porcelain now occupies the field of high voltage insulation for out-door service practically unchallenged by any other material. Glass has, to date, proven, in large pieces, to be unreliable and expensive. Molded insulations of organic materials do not stand weathering satisfactorily. Porcelain, from its very nature, is a material of high strength and remarkable elasticity. It may be defined as a thoroughly fired and vitrified material, showing a white fracture when broken. It is made in the European countries by mixing different clays to obtain the proper proportions of cohesive and fluxing qualities. Nearly all of the continental potteries mix their clays from two or more different deposits to obtain the characteristics desired. This gives a porcelain which is very pleasing in appearance but rarely gives a combination meeting all of the requirements for high tension electrical porcelain. The American practice is entirely different. The ware made in this country may be very properly described as synthetic. Clays, in the purest form obtainable, are used to give a proper glue-like character to the mixture to permit handling and forming before firing. The flux is obtained in the form of a feldspar high in potash. "Flint" in the form of pure quartz is used to give bulk and to control the amount of shrinkage in firing. By this use of clay (kaolin), feldspar and quartz obtained in remarkably pure form, the quality of the porcelain is unequalled by any made by the European method of mixing clays from different deposits.

The American method of mixing different ingredients necessarily means that all of them are brought from long distances. No clays are obtained from deposits at the potteries as is done in brick making.

The various materials are carefully weighed, cleaned and ground and mixed at the factory. They are separated from the water which is necessary in mixing by means of filtering. The filter cakes are mixed in a large "pug" mill, much like a sausage grinding machine, and are extruded from a nozzle in a continuous stream. This clay is plastic much like fresh putty.

There are several methods of forming the clay in the plastic state into the shapes which are desired. Tubes are made by forming them through properly shaped nozzles at the pug mill, described above. Rods and certain strain insulators are also formed in the same way.

Practically all other pieces made are produced by revolving either the out-

(*Continued on page 72*)

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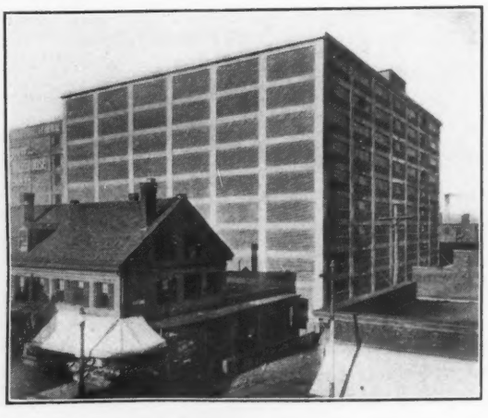

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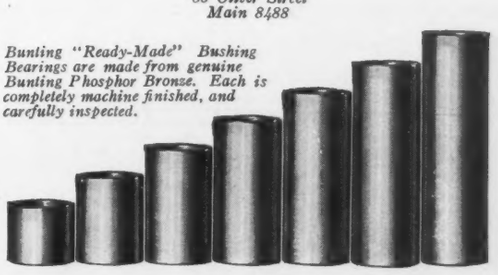

DESIGN AND MANUFACTURE OF INSULATORS

(*Continued from page 70*)

side mold, in which they are formed, or else the form which makes the inside surfaces. The moulds are made of a commercial gypsum or low grade plaster of paris. This affords a remarkably satisfactory and cheap carrier for the clay while it is drying and also helps to dry the clay by absorbing the moisture from it. Where pieces are formed in large quantities, the mould filled with a proper amount of clay is placed in a machine and the form which makes the inside surface is rapidly plunged into the clay with a rotating motion and as rapidly withdrawn. Hence, the term "plunging" of insulator pieces. Larger and more difficult pieces are made on the old-fashioned potters' wheel which has been in use for ages past. It is, of course, brought up to date by the use of electric drive and other slight modifications. In this case, the mold rotates and a profile forms the inner surface of the insulator. The potters' trade is filled with expressions peculiar to the art. This process is known as "jiggering" and there is no substitute word for it. Another process, which is a combination of "plunging" and "jiggering," is called "jollying."

As soon as the clay can be safely handled, it is removed from the mould, given the necessary retouching, the side wire grooves are cut into pin type insulators and the piece is set away in

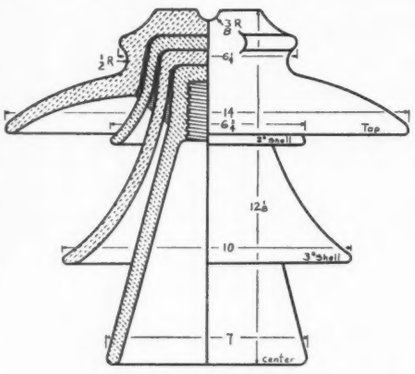

FIGURE 2

dry rooms until the last bit of moisture is removed. The use of split moulds is very rare so that it is very difficult to make any piece with re-entrant angles. Such grooves on the outside of pieces can only be made by cutting them in on removal from the moulds. All side wire grooves of pin type insulator tops are made in this manner at the time the pieces are "finished."

When the pieces are "bone-dry," they are removed from the hot room and glazed. All American insulators are fired but once.

The surfaces of the insulators which are to be engaged by cement and to which it is desired to transmit mechanical forces are prepared for this service by placing on a special glaze and while it is still moist a layer of fine particles of sand. During the firing, these become thoroughly imbedded in the glaze, giving the most uniform distribution of load to the cement and porcelain.

The pieces are then placed in "saggers" which are circular boxes of fire clay so that they will be protected in the kiln from direct contact with the frame and also to support them, so that they will carry nothing but their own weight.

Intermittent bee-hive kilns are used and are found to be the most satisfactory for the firing of pieces of varying sizes. Temperatures are checked by means of Saeger cones placed within the kilns and viewed through peep

(*Continued on page 74*)

Technology Branch, H. C. S.

THE newest books on technical and scientific subjects, published by John Wiley & Sons, and McGraw-Hill Book Company, are sent to us as soon as they are off the press. We have four bookcases of these books. We should be glad to have you come in and look them over.

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The Keuffel & Esser slide rules are standard. Those most commonly used at M. I. T. are the Polyphase, Polyphase Duplex, and the Log Log Slide Rule. We can supply these rules from stock. Prices quoted on request.

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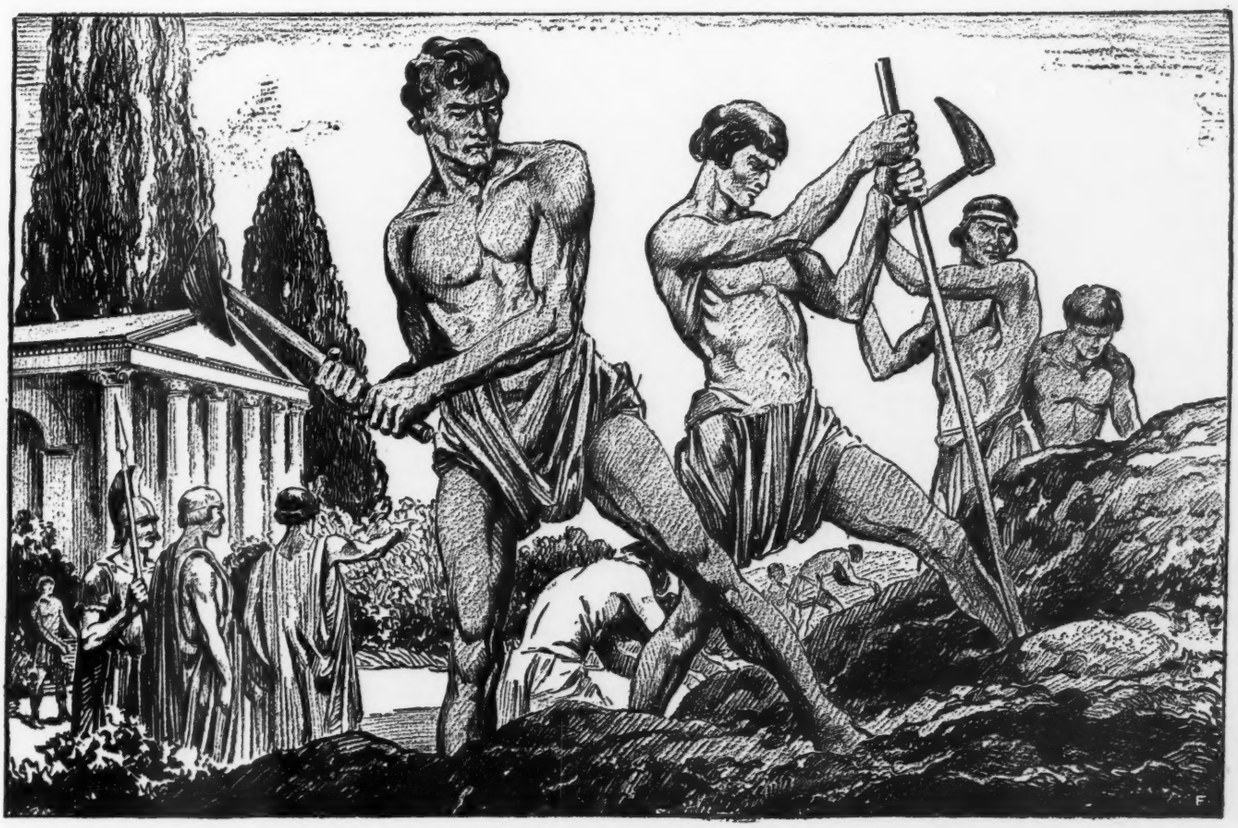

Building the Appian Way

Late in the fourth century B. C., Appius Claudius began a campaign for a road which would connect Rome with its southern provinces at Brindisi. The Roman Senate for a time balked at the great expense. Finally, Appius Claudius agreed to defray part of it from his own vast fortune.

Grading and digging stone for the road bed and pavement of this famous highway begun in 312 B. C. was a long, laborious task, which required thousands of soldiers and slaves.

The digging had to be done by hand. To obtain paving stones, slaves cut channels in the basalt to the required depth around the block, and then pried it out with iron bars. The smaller stones for ballast were chopped out with picks and hammers.

Appius Claudius cared little for time and labor. The cost of his methods would be prohibitive to the modern contractor, quarryman, or mine operator. Today, even dynamite, the great labor saver of this age, which has made possible a highway to the summit of Pikes Peak, has to be scientifically selected.

For work on which it is suited, Hercules Special No. 1 reduces blasting costs. It contains one-third more cartridges per case than 40% dynamite which it usually replaces, cartridge for cartridge, at a saving of about twenty-five percent. Hercules Special No. 1 contains nothing but the highest grade of standard materials and has thoroughly proved its dependability.

Write to our advertising department, 939 King Street, Wilmington, Delaware, for a booklet on "Eliminating Waste in Blasting".

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AUBURN BALL BEARING CO.

44 Elizabeth Street
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Trade Mark

INSULATORS

(*Continued from page 72*)

holes. Proper firing of electrical porcelain requires a temperature of about 2400 degrees F., the firing cycle taking nearly a week.

Upon removal from the kiln, the pieces are all carefully inspected for imperfections and are then all given a thorough electrical test by placing them in large groups upon test racks and applying a voltage to them sufficient to arc them over. Multi-part insulators, such as the cemented suspension units, and the pin types, are then cemented together. Shortly after they are assembled, they are placed in steam rooms so that the cement will be thoroughly expanded during the time of setting and also thoroughly supplied with moisture for complete hydration. This is a most important process for it thoroughly protects the insulator from subsequent damage due to the expansion of the cement, either by heat or absorption of water. Before shipping, all insulators are again given a vigorous electrical test to insure that no pieces have been damaged in handling after the previous test.

With suspension insulators chiefly strength tests will be required. A good suspension insulator will easily stand over nine thousand pounds before failing and insulators are available which will give far greater strength even than this. With pin type insulators, it is rare that strength tests are made for generally there is liberal margin in strength over that required.

Many of the early insulators suffered greatly because of low firing. That porcelain might be compared with the semi-vitreous ware which is commonly found in the cheaper dimmer sets. It is needless to say that the absorption of water within the pores of the insulator result in ultimate loss of the insulator by puncturing. The most desirable method of testing porcelain for porosity is to place a freshly broken piece in a solution of dye in alcohol. It is also generally customary to place this under very high pressure although a test which would be quite satisfactory could be made without the use of pressure. With freshly broken bits, the pores will probably not be filled with moisture so that the capillary attraction will draw the dye into them. Pressures up to several thousand pounds per square inch are regularly used to increase the penetration.

A Special Pyrex Flask

For Rubber Extraction

In filling your order for rubber extraction apparatus, we include a 400 cc. Pyrex Flask, made according to the special dimensions recommended by the Joint Rubber Insulation Committee.

The fact that a Pyrex Flask containing a very small amount of liquid will stand up when heated makes it ideal for extractions.

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Scientific Instrument Makers

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The Engineering College Magazines Associated

An organization of the eighteen leading college technical journals of the country; it was founded for the purpose of raising the standards of college engineering journals and in this way serving to better advantage the alumni and undergraduate engineers, and the advertisers desiring to reach this field.

There are *twenty-five thousand* subscribers eager to know all about the latest developments in commercial engineering to whom no better or more pleasing approach can be made than in their own college magazine. There are *fifteen thousand* student subscribers anxious to know and understand the concerns they will be affiliated with when they graduate.

THE TECH ENGINEERING NEWS, as founder of this group, stands ready to coöperate with any engineering concern desirous of reaching the most fertile field of potential users of engineering equipment ever brought together for the service of the advertiser.

The same advertisement on the same size page appears at the same time in eighteen college technical journals

KREOLITE

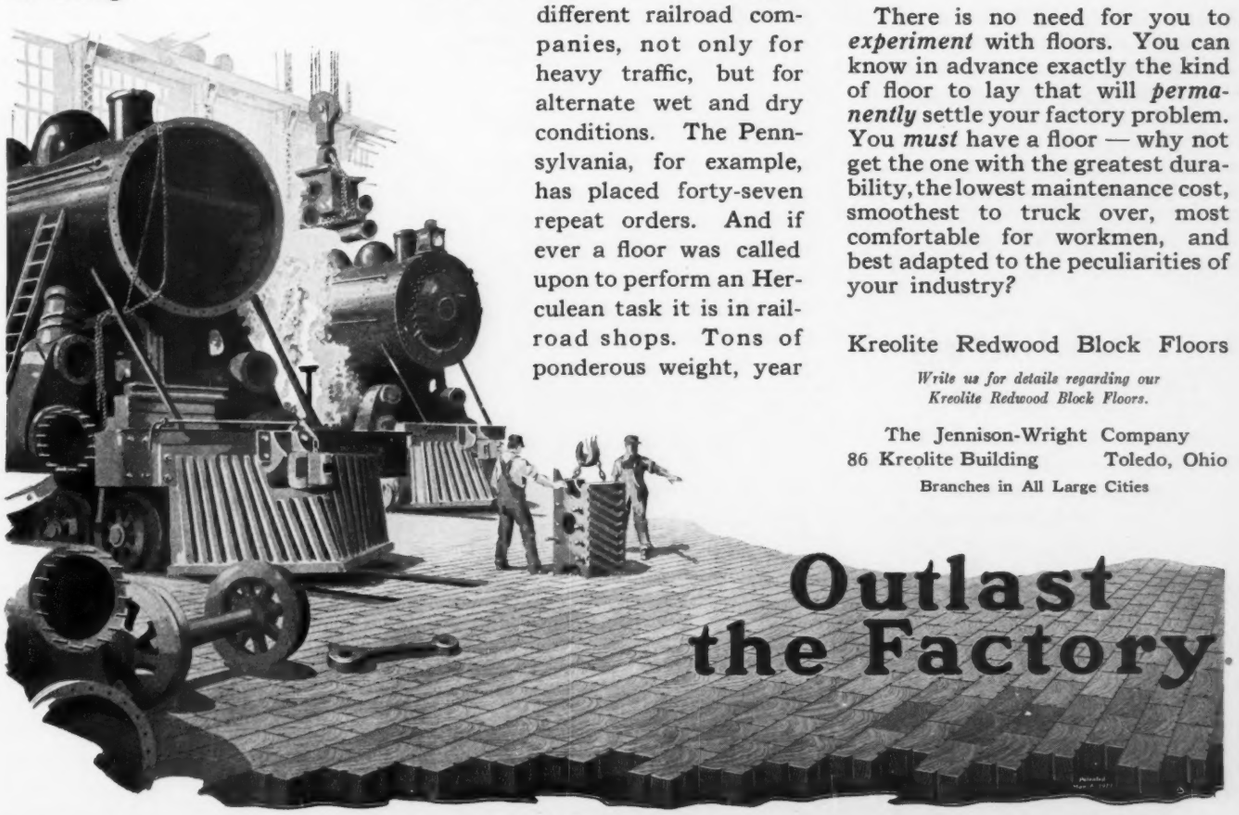
Weight of Engines Furnishes Weight of Evidence

EVERY industry has its own difficult floor problems. Our many years of experience with all kinds of floor problems is your protection against mistakes. Architects, engineers, contractors and plant managers continually welcome the aid of our factory floor engineers, both for new and old installations. It is *yours* for the asking.

Kreolite floors have established themselves as the *one* floor surface best qualified to meet every condition.

What could be better proof of their durability than their record of long life in railroad shops? Experience with all kinds of floors has proven the superiority of Kreolite block to twenty-eight different railroad companies, not only for heavy traffic, but for alternate wet and dry conditions. The Pennsylvania, for example, has placed forty-seven repeat orders. And if ever a floor was called upon to perform an Herculean task it is in railroad shops. Tons of ponderous weight, year after year of grinding strain, and a constant terrific abuse, give Kreolite floors the supreme test to prove their worth. The tough end-grain of the wood resists wear. The thorough impregnation of the block prevents decay and disintegration. Patented grooves anchor Kreolite floors solidly together.

There is no need for you to *experiment* with floors. You can know in advance exactly the kind of floor to lay that will *permanently* settle your factory problem. You *must* have a floor — why not get the one with the greatest durability, the lowest maintenance cost, smoothest to truck over, most comfortable for workmen, and best adapted to the peculiarities of your industry?



Outlast the Factory

Kreolite Redwood Block Floors

Write us for details regarding our Kreolite Redwood Block Floors.

The Jennison-Wright Company
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Branches in All Large Cities

WOOD BLOCK FLOORS

MEASUREMENT OF STRUCTURAL STRESSES

(*Continued from page 50*)

The lower end of leg (*e*) is provided with a hard steel point (*f*) identical with the two points f_1, f_2 at the other end of the instrument. These are the three contact points that transmit the stresses from the members under test to the mechanism of the instrument. They make their own centers after any paint is cleaned off the metal.

As the stress varies in the member under test the leg (*e*) will oscillate and carry mirror (*c*) with it. The angular movement of this mirror is increased by causing a fixed point (*z*) to bear against the back of the mirror case which is pressed against (*z*) by a spring. The vertical position of (*z*) is alterable for calibrating the instrument and is adjusted by simultaneously turning screws (*x*) and (*y*) through the same angle thus bringing point (*z*) nearer to or further from the axis of oscillation of mirror (*c*). The horizontal adjustment of (*z*) is effected by merely turning screw (*x*), which by altering the tilt of mirror (*c*) enables the operator to bring the moving spot of light into any required position.

The other image of the horizontal slit (*b*) on the back of the vertical slit (*a*), also forming a spot of light is reflected by the fixed mirror (*d*). It is this spot of light from the fixed mirror that forms a base line on the record, when a film is used.

If the recording spot moves upwards from its zero position it will indicate compression in the member under test; any movement downwards from zero position denoting of course, tension.

For visual observation the slit (*a*) is removed and the glass scale substituted, thus permitting images of the illuminated slit to be seen on the scale as two horizontal bars of light, one of which is fixed and forms the base, and the other moving up or down and denoting tension or compression as the case may be as before, according to circumstances.

The reflex viewing window (*h*) is for inspecting the spots of light that make the record, while a simple device consisting of button (*j*) and mirror (*k*) permits of the position and intensity of the spots of light being viewed at any time without fogging the films exposed in the instrument.

A battery is provided with a resistance which permits of the current being varied according to the speed of film winding, while the measuring of the vibrations, frequency and the rate of change of stress is effected by a disk connected with a clock escapement, thus the base line is broken as – – – – – , each dash and each space representing one fourth second of time. This is irrespective of the rate of film winding.

The latter can be done either by hand or by a motor of special design worked from the accumulators in the battery box. The latter has the advantage of a greater speed variation and instant starting up. The variable speed winder for hand operation is provided also, and connected to the instrument by a flexible cable, composed of short lengths of shaft connected by universal joints.

It is arranged on the assumption that the operator will turn at a constant speed of 150 r.p.m. The speed of this flexible shaft and consequently the rate of film traverse, can, however, be varied.

The time required for taking a record of stress in a bridge member

(*Continued on page 78*)

Selected Grades

Anthracite

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INDUSTRIAL BUILDINGS SHOULD BE WELL LIGHTED.

From the employer's viewpoint, the big difference between men who work out of doors and those who perform tasks inside the building, is the factor of light. Daylight furnishes sufficient illumination outside during the daytime working hours for men to pursue their tasks efficiently and safely. But the proposition of getting enough daylight into the interior of industrial buildings, requires some thought.

It is not a difficult problem by any means, and any employer can take advantage of daylight and utilize it for lighting his building during the daytime, if he desires. It is an excellent light, especially suitable for the eyes, reducing eye strain and eye weariness to a minimum, and has the great economic advantage of costing nothing.

To utilize daylight to the utmost, we must first provide means for allowing daylight rays to enter the interior of buildings in sufficient quantity—namely, proper and adequate windows and skylights. Many excellent instances of buildings designed with a due regard to the importance of daylight lighting can now be seen in many of our industrial cities. Such buildings present the appearance of being practically all windows—"window walled," as they are termed—and this type of daylight construction is coming rapidly into favor, because it constitutes a more healthy building for large numbers of employes, both from the lighting and ventilation standpoints.

Among those who have constructed this type of modern industrial building may be mentioned: The Shredded Wheat Co., Gillette Safety Razor Co., Lyon & Healy Piano Co., H. J. Heinz Co., Corona Typewriter Co., Skinners Macaroni Co., Grape Juice Co., Dodge Bros., Nelson Valve Co., Piston Ring Co., Remington Arms Co., and a great many others.

The Larkin Co., Philadelphia, has erected a building almost entirely glass, 85% being windows, and the Loomis Breaker, operated by the D. L. & W. R. R. Co., Nanticoke, Pa., is literally a glass house, being 93.5% of glass. The new buildings of the Winchester Repeating Arms Co. have an average glass area of 58%.

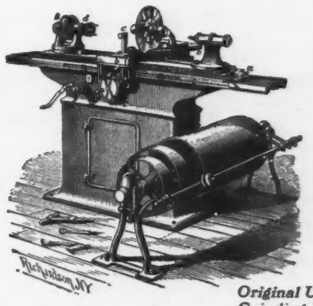
An investigation covering 18 buildings constructed by the Aberthaw Const. Co., Boston, shows that the average window area is 57.5%.

These figures indicate how important the subject of lighting is now considered by employers of industrial labor, and how well the idea has been carried out by the architects and engineers, in order that all parts of a building may receive sufficient daylight. But, in addition to providing ample window space, there is another factor which is equally important, and that is, equipping the windows with the proper glass.

The bright direct rays of the sun should not be permitted to strike the eye, and we must provide a means for reducing the glare to rays which will not be too bright. This is accomplished by glass especially manufactured for industrial windows, known as Factrolite. This glass possesses the property of breaking up the intense rays of the sun and diffusing the light into the interior of the building in proper portions, solving the problem of sun glare.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,
220 Fifth Avenue,
St. Louis. New York. Chicago.



1876

Original Universal Grinding Machine designed by J. R. Brown

The Origin of Cylindrical Grinding

SEVENTY-TWO years ago, in 1851, mechanics knew that a hardened shaft would outwear a soft one. Yet the hardening process distorted shafts enough to make them useless; and straightening was not a satisfactory method of remedying the distortions.

By 1852, however, a lathe was in use whose spindle bearings had been hardened and *ground.* These *ground* bearings are the first evidences of cylindrical grinding.

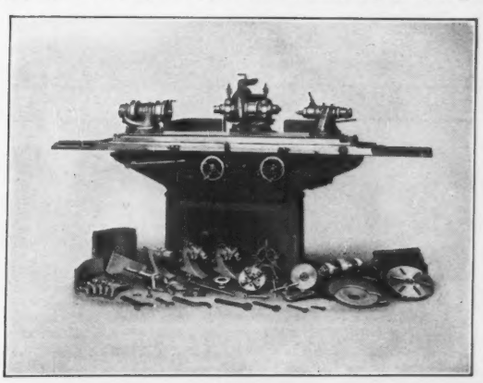
The unknown discoverer of grinding used an iron wheel having a lead rim charged with emery. This wheel, driven by an overhead belt, was mounted on the tool post of a lathe.

As early as 1864 Brown & Sharpe were building grinding machines of the lathe type. In 1868, Joseph R. Brown designed the Universal Grinding Machine which appeared at the Centennial Exposition in 1876.

From these beginnings the Brown & Sharpe line has grown to include 18 sizes of grinding machines—Universal, Plain, Crankshaft, Surface, Tool and Cutter. These high-grade machines are noted for their accuracy and capacity for producing work of the highest quality.

BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.

1923 *Brown & Sharpe No. 3 Universal Grinding Machine. Centres take work to 12" in diameter, 40" in length.*



STRUCTURAL STRESSES

(*Continued from page 76*)

depends on the length of the span, upon the length and speed of the train, and upon allowance for the approach of the train or other load. This variation in speed of filming is made by moving a pointer on the scale at the end of the speed winder to a number N which can be found by the following formulæ:

Let B = The overall length of the bridge in feet.
T = The overall length of the train in feet.
V = The velocity of the train in miles per hour.
N = The index number on the variable gear-box and the battery-box.
X = The allowance for the approach of the train in feet.

The allowance made for the approach of the train to give time for transmitting a flag signal to the operators works out in practice as bout 10+2V.

Then $N = \frac{144\ V.}{B+T+2V+10}$

Example (1). — Take V = 20, B = 100, and T = 120

Therefore $N = \frac{2880}{100+120+40+10} = \frac{2880}{270} = 10.7.$

The pointer must be put on No. 10, and the record would take up $\frac{10}{10.7} \times 20'' = 18.7''$ of the film.

Example (2).— Take V = 2, B = 100, and T = 120.

Therefore $N = \frac{288}{100+120+4+10} = \frac{288}{234} = 1.23.$

The pointer must be put on No. 1, and the record would take up $\frac{1}{123} \times 20'' = 16.2'$ of the film.

Example (3).— Take V = 1, B = 100, and T = 120.

Therefore $N = \frac{144}{100+120+2+10} = \frac{144}{232} = .62$

Now if the pointer were put on No. 1, the record would be longer than the film, therefore in this case for hand-winding the handle must be turned at $.62 \times 150 = 90$ revolutions per minute, say, instead of the normal 150.

Each instrument is, of course, calibrated by a standard calibrator. A portable calibrator forms part of the equipment for field calibration if necessary. Permanent adjustment of the fixed spot of light to zero on the scale can be made while the instrument is standing on one of the calibrators.

As regards fixing the instrument to the member under test. This can be done in any position, that is upside down, on a diagonal, inside a chord, etc., three methods of attachment being provided for.

The clamp arrangement is that most generally used, as it does not require any holes to be drilled in the bridge work, and a large number of members, such as flanges of plate girders, vertical webs of chords and booms, diagonals and vertical trusses, etc., are within its scope.

Various other methods requiring small holes will be necessary when it is desired to fix the instrument in deep trough-shaped chords or on plates over twenty inches wide and for other similar situations.

Variations of atmospheric temperature have little influence on the reading of the instrument when used on bridge work. A cloudy, dry, and windless day is best.

It is, however, advisable to allow the instrument to take up the same temperature as the bridge before a record is taken, otherwise the readings may be somewhat affected and this will be shown by the recording spot not finishing at the same distance from the zero line as it was at the commencement of the reading; an error which can be corrected before scaling the record, by drawing a new base line on the print. No temperature error can occur when taking a record of a fast train passing over a short span.

This interesting and useful instrument was designed by Mr. H. J. Fereday, a well-known English civil engineer, and is made in England by Cookes of York.

There is a good deal to understand about its use which cannot be gone into here especially as regards calibration and the taking of dead load records, such information is given in a somewhat lengthy description of the instrument by the designer.

It certainly opens up new possibilities in the study of steel bridges, the failure of which, though happily rare, yet shows that there exists in all such structures strains which even the most elaborate methods of design cannot altogether take into full account.

STARKWEATHER & BROADHURST, Inc.

Engineers and Contractors
for
Power Plant Apparatus

TELEPHONE CONGRESS 1810 **79 MILK STREET, BOSTON**

Established 1870 **Incorporated 1890**

THE WARREN SOAP MANUFACTURING COMPANY

Textile Soaps

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SAMSON SPOT SASH CORD

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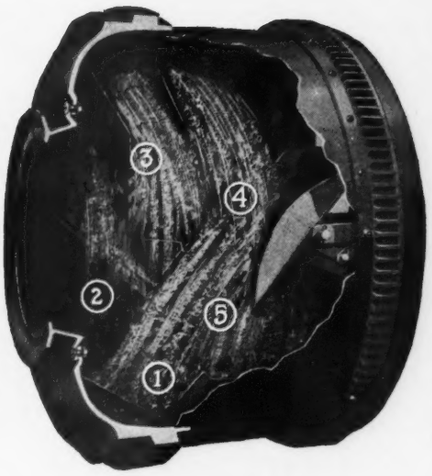
Made of extra quality cotton yarn, carefully inspected and guaranteed free from all imperfections of braid or finish. The colored spots are our trade-mark, used only with this quality.
We make braided cord of all sizes, kinds and colors, for all purposes, including sash cord, clothes lines, trolley cord, signal cord, arc lamp cord, and many special cords for special purposes.

CATALOGUE AND SAMPLES GLADLY SENT ON REQUEST

SAMSON CORDAGE WORKS **88 Broad Street, Boston 9, Mass.**

What does Koehring Dominant Strength Concrete mean to the Contractor—Owner-Engineer?



(1) Blade cuts through materials with churning action. (2) Blade carries materials up, spilling down again against motion of drum. (3) Materials hurled across diameter of drum. (4) Materials elevated to drum top and cascaded down to reversed discharge chute which (5) with scattering, spraying action, showers materials back to charging side for repeated trips through mixing process.

TO the contractor, it means reduced surfacing costs because dominant strength concrete is plastic, flows into the forms readily, is easily worked, and gives a good surface.

To the owner, it insures a structure of good appearance — and of greatest inherent worth — To the engineer, it brings the assurance that the concrete will have the strength that he assumes in his design.

The Koehring Five-action Re-mixing Principle prevents separation of aggregate according to size—coats every particle of aggregate thoroughly with cement, and delivers uniform, plastic concrete to the last shovelful of every batch.

KOEHRING COMPANY
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To be admitted to the first year class, applicants must have attained the age of seventeen years, and must satisfactorily fulfill entrance requirements in Algebra, Plane and Solid Geometry, Trigonometry, Physics, Chemistry, English, History, and French or German and one elective subject. Examinations are required in all subjects except Chemistry, History and the elective, the requirements for which are fulfilled by the presentation of satisfactory certificates. A division of these entrance subjects between different examination periods is permitted.

Entrance examinations are held at the Institute in September. In June, applicants will be examined by the College Entrance Examination Board in Boston, New York, Philadelphia, Chicago, and many other cities in America and Europe. A circular stating times and places is issued in advance by the College Board.

Graduates of colleges and scientific schools of collegiate grade, and in general all applicants presenting satisfactory certificates showing work done at another college corresponding to at least one year's work at the Institute, are admitted, without examination, to such advanced standing as is warranted by their previous training.

Graduate courses leading to the degrees of Master of Science, Master in Architecture, Doctor of Philosophy and Doctor of Science are also offered. Special Research Laboratories of Physical Chemistry, Applied Chemistry and Science have been established.

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Silentvane

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It is the most efficient fan ever designed; its use is largely in Heating and Ventilating Systems.

The Silentvane is the latest product of our research department which is devoted exclusively to improving fan design and operation.

The first fans were made sixty years ago and this improvement has been going on intensively ever since. In this new fan is embodied all that lifetime of knowledge and experience in making fans for all purposes.

The initial cost of the Silentvane is a little higher than the usual type of fan, but it shows so high an efficiency that a much smaller motor can be used thus offsetting practically the entire higher initial cost.

Then again, the operating cost is so low that a continuous saving is effected throughout the life of the fan, which is equivalent to the life of the building, affording a very satisfactory return on the original investment.

We strongly recommend the Silentvane, and our engineers will be glad to coöperate, without obligation, on any Heating and Ventilating System you have to install for any type of building.

B. F. STURTEVANT COMPANY

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Sturtevant

DAVY EXPERIMENTING WITH GARNETT IN THE ROYAL SOCIETY

The First Electrochemist

NITROUS oxide, according to the science of a century ago, was "the principle of contagion when respired by animals in the minutest quantities." Mere say-so.

Imaginative yet skeptical Humphrey Davy, who believed in experiment rather than in opinion, "respired" it and lived.

It was this restless desire to test beliefs that made him one of the founders of modern science. Electricity was a new force a century ago. Davy used it to decompose potash, soda, and lime into potassium, sodium, and calcium, thus laying the foundations of electrochemistry. With a battery of two thousand plates he produced the first electric arc—harbinger of modern electric illumination and of the electric furnace.

Czar Alexander I and Napoleon met on a raft to sign the Treaty of Tilsit while Davy was revealing the effects of electricity on matter. "What is Europe?" said Alexander. "*We* are Europe."

The treaty was at that time an important political event, framed by two selfish monarchs for the sole purpose of furthering their personal interests. Contrast with it the unselfish efforts of Sir Humphrey Davy. His brilliant work has resulted in scores of practical applications of electrolysis in industry and a wealth of chemical knowledge that benefit not himself but the entire world.

In the Research Laboratories of the General Electric Company, for instance, much has been done to improve the electric furnace (a development of Davy's arc) and new compounds have been electrochemically produced, which make it easier to cast high-conductivity copper, to manufacture special tool steels, and to produce carbides for better arc lamps.

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